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Infant Imitation and Memory: Nine-Month-Olds in Immediate and Deferred Tests

Andrew N. Meltzoff
University of Washington

Abstract

The ability of 9-month-old infants to imitate simple actions with novel objects was investigated. Both immediate and deferred imitation were tested, the latter by interposing a 24-hour delay between the stimulus-presentation and response periods. The results provide evidence for both immediate and deferred imitation; moreover, imitative responding was not significantly dampened by the 24-hour delay. The findings demonstrate that there exists some underlying capacity for deferring imitation of certain acts well under 1 year of age, and thus that this ability does not develop in a stagelike step function at about 18–24 months as commonly predicted. These findings also show that imitation in early infancy can span wide enough delays to be of potential service in social development; actions on novel objects that are observed one day can be stored by the child and repeated the next day. The study of deferred imitation provides a largely untapped method for investigating the nature and development of recall memory in the preverbal child.

The study of infant imitation has attracted theorists from a variety of orientations. Perceptual and cognitive developmentalists are interested in imitation because the reproduction of a target act can be used to measure perception, motor control, the coordination of perception and action, and, under certain conditions, memory and representational abilities (Flavell, 1985; Meltzoff, 1985a, 1985b). Imitation has also attracted the interest of social-developmentalists, for it provides an efficient channel for early social learning. At least some of the skills of early childhood are learned via the observation of adult behavior, rather than through conditioning, trial and error, or individual maturational growth, and the origins and early development of such social learning warrant investigation (Bandura & Walters, 1963; Hartup & Coates, 1970). Finally, Piagetian psychology has focused on imitative development as playing a vital role in the transition from a purely sensorimotor level to a more representational form of intellectual organization (Flavell, 1985; Piaget, 1962).

For each of these approaches, deferred imitation takes on special importance. Cognitive theorists highlight deferred imitation as a way of investigating long-term memory in preverbal infants. Deferred imitation is relevant to social theorists because the infant or child will not always be able to reproduce each adult action as soon as it is demonstrated; thus, for imitation to fulfill its social utility, the infant or child must be capable of initiating imitation long after the target display has terminated. Finally, Piagetians focus on deferred imitation as a developmental milestone that first emerges at about 18–24 months (during sensorimotor stage 6) contemporaneously with pretend play and productive language as part of a general emergence of the “symbolic function” (Inhelder, 1971; Lézine, 1973; Piattelli-Palmerini, 1980; Sinclair, 1969, 1970).

Only recently have the origins and development of deferred imitation begun to be empirically investigated. McCall, Parke, and Kavanaugh (1977) tested for deferred imitation

Author’s address: Andrew N. Meltzoff, Department of Psychology (WJ-10), University of Washington, Seattle, WA 98195.

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in 1–3-year-old children, and as predicted by Piagetian theory they found that infants first began to reproduce target actions after a delay at approximately 24 months. However, two other reports suggest that, at least under certain circumstances, such behavior can be elicited at younger ages. Meltzoff (1985b) found evidence for deferred imitation after a 24-hour delay in 14-month-old infants, and Abravanel and Gingold (1985) reported imitation after a 10-min delay in 12-month-olds. Nevertheless there are still questions about the nature of this ability before 18–24 months. It remains possible that deferred imitation before about 18–24 months is a sharply constrained phenomenon—severely limited in the number of acts that can be retained for later reproduction, and/or in the length of delay that can be tolerated.

The work reported here was designed to assess deferred imitation at a younger age than has been tested heretofore (9-month-old infants), using a long delay period (24 hours) and a variety of tasks (three items). In addition, immediate imitation was also assessed using the same age group and the same three tasks.

The immediate test was included both as a comparison with the deferred test and as a contribution in its own right because studies of immediate imitation at this particular age have not always incorporated the control conditions necessary to distinguish imitative versus nonimitative production of the target behaviors (e.g., Uzgiris & Hunt, 1975). To isolate imitative responding, control groups that do not see the target action are needed to assess the spontaneous rate of the behavior at issue, and imitation should be inferred only if these controls produce the target behavior less than do infants who are exposed to modeling. Without such controls, the production of the matching behavior after seeing the display is not unambiguous evidence for imitation because it could be produced by chance, be facilitated by the mere presence of the adult, and/or other possibilities that are best determined by the appropriate controls (see Meltzoff, 1985b; Meltzoff & Moore, 1983, for reviews).

Study 1

Method

Subjects—The sample consisted of 60 9-month-old infants who were identified through the local newspapers and recruited by a telephone call. Criteria for admission into the study were no known physical, sensory, or mental handicaps, normal length of gestation (over 37 weeks), and normal birth-weight (2,500–4,500 grams). The mean age at the time of test was 38.78 weeks ($SD = 0.73$), and the mean birthweight was 3,645 grams ($SD = 423$). Equal numbers of males and females were used. One additional subject was tested but then eliminated from the study due to excessive crying.

Testing environment and apparatus—The test took place in a small room (3.2 × 2.2 m) that was unfurnished except for the experimental apparatus. During the test the infant was seated on his or her parent’s lap across a small rectangular table (1.2 × .76 m) from the experimenter. Behind and to the left (1.0 m) of the experimenter was a video camera that was focused on the subject so as to include a record of the infant’s torso, head, and most of the tabletop. A similar camera behind and to the right (1.0 m) of the infant recorded the adult. The videotape decks recording the experiment were housed in an adjacent viewing room to reduce auditory distractions. The experiment was electronically timed by a character generator that mixed elapsed time in 0.10-sec increments directly onto the videotaped records.

Stimuli—Three novel objects designed to be highly manipulable by infants of this age were constructed from materials around the laboratory. Each object involved a different action, as described below.

The first object was an L-shaped un-painted wooden construction composed of a wooden rectangle (9.2 × 10 cm) connected by a hinge to a larger rectangular base (15.3 × 23.5 cm). The action demonstrated was to reach out and push the vertical extension over so that it lay flat on top of the base. This required a push of moderate force (.7 kg · m/s^2), which was determined by pilot studies to be within the capacity of 9-month-olds. The second object was a small black box (5.4 × 15 × 16.5 cm) with a black button (2.2 × 3 cm) mounted in a recess so that it lay .6 cm below the top surface of the box. The action demonstrated by the adult was pushing the button, which then activated a switch inside the box and produced a beeping sound. The beep was a rapidly pulsating tone of about 2,000 Hz, and its intensity, measured at the approximate location of the infant's head, was 61 dB Sound Pressure Level. The third object was a small orange plastic egg (6.4 cm high and 4.5 cm in diameter at its widest point) cut laterally in half and filled with a few metal nuts so that it rattled when shaken. The action demonstrated was to pick up the egg and shake it.

The hinged toy was oriented with the edge of the vertical piece facing the infant and could be pushed flat by moving it from right to left The black box was tilted up at a slight angle (30°) by wooden supports with the top directly facing the subject During the response period these objects were set in velcro strips to prevent them from accidentally being pushed off the table by the infant while manipulating them. For all groups, the egg presented to the infants in the response period was identical to the one used by the model except that it did not contain any noisy fillings. This prevented any accidental rattling sounds from the infant just touching the toy.[1]

Procedure—Upon arriving at the university, infants and parents were escorted to a waiting room where they remained for about 10–15 min while the parents completed the necessary forms. They were then brought to the test room, and the infant and male experimenter interacted by handing rubber toys back and forth across the test table until the infant seemed comfortable with the experimenter and the room. This "warm-up" period usually required 1 to 3 min, and at that point the test began.

In the imitation group (*N* = 24), each infant was sequentially shown the three target actions (hinge folding, button pushing, egg rattling). The three test objects were shown one at a time in all possible test orders, balanced across the group. Each target action was demonstrated three times in a 20-sec modeling period. At the end of the three modeling periods, the infants were given a sequence of three response periods to assess whether they would reproduce the actions they saw. The objects were brought back one at a time in their original sequence and placed on a spot directly in front of the infant for a 20-sec response period starting from the infant's first touch of the toy. If the infant became distracted during the modeling or response period, the experimenter would say "look over here" or "oh, see what I have," but never used words relating to the tasks at hand, such as "push," "shake," "fold," "copy," or "imitate."

The control groups (totaling 36 subjects) proceeded identically to the imitation group except that they did not see the target actions modeled. To approximate different aspects of the display, three different control groups were used: a "baseline control," an "adult-touching control," and an "adult-manipulation control."

For the baseline condition (*N* = 12), the modeling periods were simply omitted and the infants were timed for the three sequential 20-sec response periods with the test objects; all else was identical to the imitation condition. This control assesses the spontaneous

[1]It is possible that the infants in the imitation group might have expected the egg to make a sound when they shook it in the response period, but this should not have influenced the results because the first shaking motion was the only action scored.

probability of infants producing the target actions in the absence of previous contact with the stimuli or the modeled action. In the adult-touching condition ($N = 12$), infants saw the adult reach out and hold each object three times in the modeling periods, but they were not shown the particular target actions. These control modeling periods were followed by a series of three 20-sec response periods, exactly as in the imitation and baseline conditions. This condition controls for the possibility that infants might somehow be induced into producing the target actions if they see the adult approach and touch the object, even if the exact target action was not modeled. The adult-manipulation control ($N = 12$) was conducted to mimic further aspects of the target display but still without demonstrating the critical action. Infants who see that objects have consequences, that they beep or rattle, may be more motivated to manipulate them. The adult-manipulation condition demonstrated such consequences without demonstrating the target actions. For example, infants were exposed to the beeping sound made by the black box during the modeling period (as were infants in the imitation group); however, this sound was produced by having the experimenter place both his hands on the sides of the box and surreptitiously use his thumb to activate a small switch in the back of the box that was invisible to the child. Similarly, infants were exposed to the rattling sound made by the egg during the modeling period; however, this was accomplished by having the adult use one finger to spin the egg in place so that it made the sound. Finally, regarding the third object, infants were shown that the small flap could move relative to the wooden base. This was accomplished by using a toy identical to that used in the imitation condition but without the metal hinge screwed on. Infants saw the object with the flap already placed in a horizontal position (the “end state” for the flap in the imitation group), and it was then moved toward the infant and back while being held between the experimenter’s thumb and forefinger. The forward and back movement approximated the distance traversed by the arc of the flap in the imitation condition. At the end of the control modeling periods the objects were presented to the infants for the 20-sec response periods, following the same procedure as the other test conditions.

Although no differences in the production of the target behavior under the three control conditions (baseline, adult touching, adult manipulation) were anticipated (Meltzoff, 1985b, used a similar design and found no significant differences), taken together they provide an especially rigorous assessment of the probability of nonimitative production of the target behaviors and thus permit the inference of imitation if differentially more target behaviors are seen in the imitation versus control groups.

Response scoring—The videotape records of the response periods for the experimental and control infants were identical in the sense that all infants had a series of three 20-sec response periods. Thus there were no artifactual clues on the videotape as to whether or not the infant had been exposed to the target action. A scorer who was naive to group assignment viewed these response periods and provided a dichotomous yes/no code as to whether the infant produced the target action with each object. A “yes” for the button was recorded if the button was pushed in far enough to trigger the beeping sound automatically; a “yes” for the egg was recorded if the infant shook the object, where shake was defined as a quick bidirectional movement in which the trajectory retraced itself. A “yes” code for the hinge object was recorded if the vertical flap was folded down through an arc greater than 45° toward the baseplate. A randomly selected 25% of the subjects were rescored to assess both intra-and interobserver agreement on the number of target behaviors infants produced. Both a Pearson r and the kappa statistic, which is an index of agreement, ranging from 0 to 1.00, that incorporates a correction for chance (Applebaum & McCall, 1983; Cohen, 1960), were calculated and respectively yielded the following values: intraobserver agreement, .93, .91; interobserver agreement, .87, .91.

Results and Discussion

Each infant was presented with three test objects and therefore could duplicate 0–3 of the target behaviors. For the purposes of the main nonparametric analysis, each infant's response was classified as either "low" (0–1 target behaviors produced) or "high" (2–3 target behaviors produced), as shown in Table 1. A 4×2 chi-square test assessing the effects of the four experimental conditions on the infants' behavior reached significance, $\chi^2(3) = 16.00$, $p < .01$, with infants in the imitation condition producing more target behaviors than the controls. Because several of the expected frequencies in this Table are less than 5, these same data were also reanalyzed as a 2 × 2 table contrasting the imitation condition ($N = 24$) with the combined controls ($N = 36$). These results were also highly significant, $\chi^2(1) = 11.20$, $p < .001$. Although the underlying data are more amenable to non-parametric analysis, it is worth noting that the same pattern of results is also obtained using a one-way ANOVA, which shows that the number of target behaviors (possible range = 0–3) varies significantly as a function of experimental condition, $F(3,56) = 6.30$, $p < .001$. In accordance with the imitation hypothesis, a planned comparison between the imitation condition and the mean of the controls shows that infants produce significantly more target behaviors in the imitation than in the control conditions, $t(56) = 4.02$, $p < .0001$.

These data indicate that infants' behavior is influenced by the adult model. Infants in the control conditions are less likely to produce the target actions than those infants who see them performed. The inclusion of the controls allows us to infer that infants in the imitation group were not simply producing the target behaviors because they were aroused by seeing the adult approach and touch the toy or because they heard the consequences (beep, rattle) of the adult's manipulation. These possibilities were addressed by the types of controls used.

The results show that 9-month-olds can imitate certain simple actions with novel toys under conditions in which little delay is involved. Will imitative responding be dampened if a lengthy delay is interposed? Or, is deferred imitation wholely absent after a lengthy delay, perhaps tapping a significant constraint in the cognitive organization of young infants? These questions were addressed in Study 2.

Study 2

Method

Subjects—The subjects were 60 normal 9-month-old infants, including equal numbers of males and females. The criteria for admission into the study were the same as those used in Study 1. The mean age was 39.14 weeks (SD = 0.69) and mean birthweight was 3,499 grams (SD = 417). An additional seven infants were tested but eliminated from the study: five for not returning for the second test after the delay, one for crying, and one for a procedural error. These eliminated subjects were distributed approximately evenly across the test conditions.

Test environment, procedure, and scoring—The infants were tested in the same laboratory, using the same objects, under the same general procedure and design as Study 1. The studies differed only by the introduction of a 24-hour delay (actual range = 23.5–24 hours). The delay interval was interposed in the following manner. For the imitation condition, the three actions were sequentially modeled as before. The infants were then sent home and scheduled for a visit the next day. When they returned to the test laboratory, the experimenter engaged in a short warm-up with rubber toys (1–3 min) until the infants seemed comfortable. Next the sequence of three 20-sec response periods was presented exactly as had been done in the immediate imitation experiment. For the baseline control, infants came to the laboratory on day 1, entered the test room, and engaged in the rubber toy warm-up just as had the infants in the imitation group. They then were sent home. On day 2, they were treated identically to those infants in the imitation condition, that is, they were presented the sequence of three response periods. For the adult-touching and adult-manipulation controls, the procedure was the same except that infants saw the three control events (these were described in Study 1) on the first day before being sent home. On the second visit they were treated identically to those in the imitation condition.

The videotapes of the response periods were shown to an observer who remained blind to the infant's test condition and scored the data exactly as in Study 1. A randomly selected 25% of the subjects were rescored to assess both intra- and interobserver agreement on the number of target responses infants produced. A Pearson r and kappa statistic were both calculated and respectively yielded the following values: intraobserver agreement, .91, .86; interobserver agreement, .95, .82.

Results and Discussion

The results support the hypothesis that infants are capable of imitating after the 24-hour delay (Table 2). The 4 × 2 table assessing the effects of the four experimental conditions on infants' behavior reached significance, with infants in the imitation condition producing more target behaviors than the controls, $\chi^2(3) = 8.01$, $p < .05$. Due to small expected frequencies, the data were also reanalyzed as a 2 × 2 table contrasting the imitation condition ($N = 24$) with the combined controls ($N = 36$), $\chi^2(1) = 4.88$, $p < .05$. The outcome of the alternative parametric analysis is in line with these chi-square tests. A oneway ANOVA shows that the infants' test scores vary significantly as a function of experimental condition, $F(3,56) = 4.69$, $p < .01$, and a planned comparison shows that infants produce more target behaviors in the imitation condition than in the controls, $t(56) = 3.32$, $p < .005$.

It is of interest that the pattern of results is nearly identical either with the 24-hour delay (Study 1) or without it (Study 2). Inspection of Table 1 and Table 2 reveals that the imitation effect not only replicates, but that the profile of the results is essentially unaffected by the delay. A comparison of the results across the two studies can most easily be assessed statistically by comparing the two 2 × 2 contingency tables reported above. In the immediate test, 50% of the subjects in the imitation group received a high imitation score, as opposed to only 8.33% in the controls; in the deferred tests, the comparable comparison was 50% versus 19.44%. A chi-square test for the homogeneity of these two tables (Fleiss, 1981) reveals no significant difference ($p > .20$), and it is noteworthy that the data in the imitation conditions themselves were in fact identical (50%) whether infants responded immediately or after a delay.

The fact that the results are so similar across the two studies allows us to combine the studies meaningfully, and this larger sample size of 120 subjects in turn affords a further look at the effectiveness of imitation. It is striking that across the studies nearly 20% of the subjects in the imitation condition reproduced three of the target displays. These subjects retained and duplicated all three of the events they were shown. The control infants document that the production of the three target behaviors is highly improbable in the absence of seeing the relevant displays. Across both studies, 0 of the 72 control infants produced all three targets. The difference is highly significant ($p < .0005$, Fisher exact test). Once again, there is no effect of delay on this performance, inasmuch as five of the 24 infants in the deferred test reproduced all three behaviors and four of the 24 infants in the immediate test did so.

An alternative parametric analysis combining the results of the two studies involves a condition (4) × delay (2) ANOVA. The relevant means are displayed in Table 3. The main effect of condition is significant, $F(3,112) = 10.39$, $p < .001$, and a planned comparison shows that infants produced significantly more of the target behaviors in the imitation condition than in the controls, $t(116) = 5.22$, $p < .0001$. There was no main effect of delay, $F(1,112) = .34$. There was also no condition × delay interaction, $F(3,112) = .44$, indicating that the imitation effect was not dampened due to the 24-hour delay.

General Discussion

These studies show that 9-month-old infants will imitate simple actions using novel toys both immediately and after a delay. Infants will close a wooden flap after witnessing an adult do so, they will push a button after seeing this act, and they will duplicate the shaking of a small plastic egg. This work does not assess the degree to which more novel motor patterns, actions involving complex temporal or spatial sequencing, or activities with more symbolic or cognitive loadings will be imitated at this early age. On the basis of other research (Abravanel & Gingold, 1985; Killen & Uzgiris, 1981; McCabe & Uzgiris, 1983; McCall et al., 1977), it seems likely that there will be interesting constraints on the types of tasks such young infants will copy. For example, in the current study, as with virtually all experiments conducted to date with infants, the actions tested in the imitation condition occur with some nonzero probability in the controls. It would now be informative to test whether a behavior with truly a zero probability in the absence of modeling would be duplicated either immediately or after a delay. Similarly, it would be informative to probe the limits of imitation by testing the degree to which modeling can influence infants' behavior on more symbolic or problem-solving tasks such as object permanence (Wishart, 1986) or the categorization of objects (Gopnik & Meltzoff, 1987). However, even without these probes into the limiting conditions of imitation, the current research establishes several interesting things about what infants *can* do at this age and thus extends our current knowledge about early imitation. The findings have implications for social, Piagetian, and cognitive developmental theories, as discussed in turn below.

From a social viewpoint it is noteworthy that the design involved showing infants first one, and then a second, and finally a third act, and only then allowing them to respond. Generalizing from the laboratory to home interaction is difficult; however, it is possible to suggest how successful imitation under these circumstances might be of service in everyday life. Consider that parents and siblings do not always allow infants access to one toy before showing other potentially competing acts with different toys. The current findings show that at least by 9 months old these social realities are not in themselves enough to block the imitation of the now absent events. Evidently even these young infants can hold in mind more than one event for subsequent reproduction once they get access to the toy. These findings are thus compatible with the notion that imitation could be functional even between young infants and their siblings or other "real-world" models who do not always allow an immediate response before proceeding to display other behaviors.

The results are also relevant to Piagetian theory, for the experiments were carefully designed to be sensitive to three critical distinctions made in this theory. (1) The control groups eliminated the possibility that infants in the imitation condition produced the target behavior on day 2 solely because they were more comfortable with the toys, laboratory, or experimenter on the second day. The subjects in both the adult-touching and adult-manipulation controls were exposed to the same toys for the same length of time, and they too were brought back on a second day. Had such controls not been included, few theoretical implications could be drawn from the delay experiment. (2) It is noteworthy that nearly 20% of the subjects in the imitation condition, as opposed to 0% in the controls, reproduced all three of the target actions modeled. This indicates that at least some 9-month-olds could simultaneously keep in mind three different inputs over the 24-hour delay and provides a rather strong demonstration of deferred imitation in this age group. (3) The design ensured that the infant's reproduction on day 2 was based on a memory of the displays and not on a memory of the infant's *own action* from day 1.

This last issue has relevance for a general cognitive-developmental and especially a Piagetian viewpoint. Had infants been allowed to engage in immediate imitation, and then return for a subsequent deferred test, they could simply have been retaining and retrieving their own previously performed actions. It has been argued that the retention and duplication of one's previous acts is a lower-order cognitive task than is initiating a target behavior for the first time on the basis of a stored representation of the display (Piaget, 1952, 1954, 1962). An extreme case of the former is the reinitiation of a conditioned response after a delay, which has been demonstrated by Rovee-Collier, Sullivan, Enright, Lucas, and Fagen (1980) in 3-month-old infants and is generally not seen as addressing the narrower Piagetian concern.

Thus many theorists acknowledge that some form of memory is involved in the following sequence of events: immediate imitation followed by a delay and then a reinitiation of this imitation after the delay. However, this is not classically regarded as a pure case of deferred imitation, and its first appearance would not be predicted to occur only at sensorimotor "stage 6." The current study was designed to respect this theoretical distinction, and infants were not given the opportunity for immediate duplication before being tested in the deferred situation. As such, the findings suggest a downward revision in the age at which some form of legitimate deferred imitation can be performed.

The current work does not directly address the larger idea associated with Piaget's theory and others (Piaget, 1952, 1962; Piattelli-Palmarini, 1980) of a synchronous "stage 6" shift involving symbolic play, deferred imitation, manual search for invisibly displaced objects, and productive language, because these additional measures were not also taken on these same subjects. The results show, however, that at least some capacity for deferred imitation is present under 1 year of age, which is well before these other developments have been typically observed. This suggests that the initial ability to defer imitation for a lengthy delay may not emerge as a contemporaneous achievement with other aspects of the symbolic function and underscores the need for reexamining which cognitive achievements hang together with which during infancy and the transition to early childhood (Corrigan, 1979; Fischer, 1980; Gopnik & Meltzoff, 1984, 1986, 1987; Uzgiris, 1973).

The results also are informative for theories of infant memory, for the deferred imitation effects after 24 hours are virtually identical to those of immediate imitation. This finding, while at first somewhat surprising, is reminiscent of Fagan's (1973) report that infants' performances on a recognition-novelty task did not strikingly decline after 24-hour delays or even longer. Young infants may take longer to encode certain stimuli than older infants (Fagan, 1982; McCall & McGhee, 1977), but once the stimuli are encoded, they seem able to retain them over lengthy delay intervals. On the basis of this work and other ongoing studies in our laboratory (e.g., Meltzoff, 1985a, 1985b), it can be hypothesized that once an event is encoded, the retention interval per se is not a narrowly delimiting factor in early infancy, which in the context of studies of imitation translates into the suggestion that imitative development may not be characterized by a sudden stagelike shift in the raw ability to defer duplicative actions. The strong version of this hypothesis is that nearly any motor pattern that infants are capable of imitating immediately can also be imitated under carefully designed delay conditions. Having found that delay time under the present procedure did not reduce performance in the imitation tasks, it now becomes interesting to introduce systematic interference during the retention interval. By varying the type and content of the interfering stimuli, especially by introducing specific visual versus motor tasks during the delay, it should be possible to investigate the nature of the stored representation used as the basis of deferred imitation by young infants. Is the absent event stored in “visual,” “motor,” or in some other terms?

Finally, the relation between the present work on deferred imitation and previous work on infant visual memory (Cohen & Gelber, 1975; Fagan, 1982) bears mention, for they are different yet complementary in nature. The previous work has largely focused on “recognition” memory in which the infant’s ability to make a perceptual distinction between a novel versus familiar perceptual pattern is tested over various delay intervals. The deferred imitation paradigm taps abilities more akin to “recall” than recognition memory. Infants must do more than perceptually discriminate between a familiar versus novel experience. In the deferred imitation case, they must guide their gross motor behavior to reproduce the act they saw 24 hours earlier, which illustrates a kind of nonverbal recall or cued recall memory (Flavell, 1985; Meltzoff, 1985b; Sophian, 1980; Watson, in press; Werner & Perlmutter, 1979). The deferred imitation test paradigm promises to be a useful new tool in investigating long-term recall memory in young infants.

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TABLE 1

Immediate Imitation ($N = 60$): Number of Infants with High versus Low Test Scores as a Function of Experimental Condition

	Test Scores	
Condition	**Low**	**High**
Baseline control	9	3
Adult-touching control	12	0
Adult-manipulation control	12	0
Imitation	12	12

TABLE 2

Deferred Imitation (*N* = 60): Number of Infants with High versus Low Test Scores as a Function of Experimental Condition

	Test Scores	
Condition	**Low**	**High**
Baseline control	8	4
Adult-touching control	11	1
Adult-manipulation control	10	2
Imitation	12	12

TABLE 3

Means and Standard Deviations of Infants' Scores as a Function of Delay and Experimental Condition

	Delay					
	Immediate		Deferred		Combined	
Condition	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Baseline control	1.00	.74	1.17	.72	1.08	.72
Adult-touching control	.75	.45	.58	.67	.67	.57
Adult-manipulation control	.50	.52	.83	.72	.67	.64
Imitation	1.54	.93	1.58	.97	1.56	.94

NOTE.—Maximum score = 3.