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# Infant Imitation After a 1-Week Delay: Long-Term Memory for Novel Acts and Multiple Stimuli

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## Abstract

Deferred imitation after a 1-week delay was examined in 14-month-old infants. Six actions, each using a different object, were demonstrated to each infant. One of the six actions was a novel behavior that had a zero probability of occurrence in spontaneous play. In the imitation condition, infants observed the demonstration but were not allowed to touch the objects, thus preventing any immediate imitation. After the 1-week delay, infants returned to the laboratory and their imitation of the adult's previous actions was scored. Infants in the imitation condition produced significantly more of the target actions than infants in control groups who were not exposed to the modeling; there was also strong evidence for the imitation of the novel act. From a cognitive perspective deferred imitation provides a means of assessing recall memory and representation in children. From a social-developmental viewpoint the findings illustrate that the behavioral repertoire of infants and their knowledge about objects can expand as a result of seeing the actions of others.

Developmental theories differ in the extent to which imitation is viewed as making a contribution to the growth of a child's behavioral repertoire. Piaget (1952, 1954) tended to emphasize individual discovery and to minimize social imitation as a mechanism for acquiring new behaviors. Conversely, Bandura (1969, 1986) highlighted imitation as a channel for learning in school-age children, and Meltzoff (1985, 1988a, 1988b, in press) has emphasized the powerful influence of imitation in infancy. Regardless of the differing perspectives on the function of imitation, there is broad agreement that infants' ability to perform imitation after a delay, and especially deferred imitation of novel behaviors, is a milestone achievement both from a cognitive and a social perspective (Bandura, 1986; Flavell, 1985; Meltzoff, 1988b; Piaget, 1962). The acquisition of new behaviors through observation, particularly when they can delay production until significantly later, potentially provides both an avenue for social learning and a nonverbal measure of memory and representation.

Although imitation after a delay has been actively investigated in school-age children (Bandura, Grusec, & Menlove, 1966; Bandura & Walters, 1963), there have been only a few such experimental investigations in infants. McCall, Parke, and Kavanaugh (1977) reported

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imitation after a 1-day delay in 26-month-old subjects. Meltzoff (1985) found deferred imitation of a simple action after a 1-day delay in 14-month-olds. Recently, it has been reported that infants as young as 9 months of age can observe an adult's behavior on one day and then delay their production of it for 24 hr (Meltzoff, 1988a).

The longest delay in these infant experiments has been 1 day, but studies of infant memory using tests of recognition (Fagan, 1973) and conditioned responses (Rovee-Collier, Sullivan, Enright, Lucas, & Fagen, 1980) demonstrate that infants can store information for appreciably longer than 24 hr. One purpose of the study reported here was to investigate whether young infants could delay their imitation of adult displays over a period as long as 1 week. If one is to contemplate seriously the hypothesis that imitation may play a role in infants' behavioral acquisition, it would be useful to show that deferred imitation can span lengthy delays of at least this magnitude.

A second purpose of the study was to broaden the range of acts that has been investigated in deferred imitation studies to include acts that are novel. There is a consensus among most theorists that the imitation of novel acts is of greater impact in social learning than the duplication of well-practiced, familiar behavior. The few existing studies of novel imitation have tested infants' performance without a delay. The conclusion has been that reproducing novel acts is cognitively more difficult than the imitation of habitual/familiar ones (Killen & Uzgiris, 1981; Masur & Ritz, 1984; McCabe & Uzgiris, 1983; Uzgiris & Hunt, 1975). There has been no experimental investigation of deferred imitation of a novel behavior in children less than 2 years of age, but the common age estimate for the onset of such activity is approximately 18 to 24 months of age, during Stage 6 of the sensory–motor period (Flavell, 1985; Piaget, 1962; Smolak, 1986). In the study reported here I investigated the ability of 14-month-old infants to perform deferred imitation of a novel act.

The design of this experiment was such that infants were not allowed to imitate immediately upon observing the actions. They were confined simply to observing the demonstration at Time 1 and were first given the opportunity to imitate after the 1-week delay. A second type of design, sometimes reported in the literature, is one in which infants are permitted to imitate the adult immediately and then to repeat the imitation after a delay without any further modeling. McCall et al. (1977) used both types of procedures, and the studies by Meltzoff (1985, 1988a) used only the type in which no immediate imitation was permitted. These authors and others (Flavell, 1985; Piaget, 1962) all concur that the more stringent test of memory and deferred imitation is posed by the first type of design (the one adopted here), in which the infants are not merely repeating their own behavior but committing to memory an act that is as yet unperformed by them.

Finally, another dimension on which previous studies of deferred imitation have differed is in the number of acts modeled for the infant at Time 1 and, therefore, the number the infants were to keep in mind across the delay. The existing studies range from one act (in Meltzoff's, 1985, test of 14-month-olds) to four acts (in the McCall et al., 1977, test of 26-month-olds). In the experiment reported here 14-month-old infants were presented with a larger number of acts—six of them. Thus, the study provides the first test of deferred imitation after a 1-week delay using multiple targets, at least one of which was novel.

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# Method

## Subjects

Thirty-six 14-month-old infants served as subjects. Criteria for admission into the study were that an infant have no known physical, sensory, or mental handicaps, be full term (more than 37 weeks gestation), and be of normal birth weight (2,500–4,500 g). The mean age of the subjects at the time of the first visit was 61.44 weeks (*SD* = 0.60, range = 60.00–62.29). The mean birth weight was 3,444 g (*SD* = 394, range = 2.693–4.167). Equal numbers of boys and girls served as subjects. An additional 6 infants were dropped from the study, 5 for not returning for a second visit and 1 because of a procedural error.

## Testing Room and Apparatus

The test was conducted in an unfurnished room with the infant seated on his or her parent's lap in front of a small, rectangular table (1.2 × 0.76 m). The experimenter sat to the right and on the same side of the test table as the parent, about 20 cm away, shoulder to shoulder. The experimenter presented the displays in front of himself so that they were clearly visible to the infant but outside of the infant's reaching space. A video camera was focused so as to record the infant's torso, head, and a portion of the tabletop in front of the infant. The experiment was electronically timed by a character generator that mixed elapsed time in 0.10-s increments directly onto the video record. To reduce auditory distractions, the video recorder was housed in an adjacent viewing room.

## Materials

Six objects served as test stimuli. All but the bear and the egg were objects that these infants had never seen or played with before (because they were specially constructed in our laboratory for this experiment and were not commercially available). The first object was a dumbbell-shaped toy that could be pulled apart and put back together again. It consisted of two 2.5-cm wooden cubes, each with a 7.5-cm length of plastic tubing extending from it. One length of tubing was slightly narrower and fit inside the other. The action demonstrated was to pick up the object by the wooden cubes and to pull outward with a very definite motion so that the toy came apart. The second object was an L-shaped device. It consisted of a flat rectangular base (15.3 × 23.5 cm) with a 2-cm thick wooden flap (9.2 × 10 cm) connected to the base by a hinge. The action demonstrated was to reach out and push the vertical flap over so that it would lie flat on top of the base. The 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 third object was a small black box (5.4 × 15 × 16.5 cm) with a slightly recessed button (2.2 × 3 cm) on the top surface. The box was tilted up off the table by wooden supports so that the top surface was facing the child. The action demonstrated by the experimenter was pushing the button, which then activated a switch inside the box and produced a beeping sound. The fourth object was an orange plastic egg (4.5 × 6.4 cm) that was glued to a small support base so that it could sit vertically. The object was filled with metal so that it rattled when shaken. The action demonstrated was to pick up and shake the egg. The fifth object was a small stuffed bear (8 × 11 cm) with a thin string attached to its top in the form of a loop. The action demonstrated was to suspend the bear by the string and to jiggle it up and down so that it appeared to "dance" on the tabletop. The sixth object was

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a 4.3-cm-high wooden box (19 × 26.7 cm) with a translucent orange plastic panel for a top surface. The novel action demonstrated was for the experimenter to lean forward from the waist and touch the panel with the top of his forehead. When touched, the panel was automatically illuminated by a light bulb inside the box.[1]

## Design and Procedure

Parents were contacted by telephone and scheduled for two appointments 1 week apart. When they arrived at the University for the first visit the parent and child were escorted to a waiting room in which the parent completed consent and birth information forms. They were then led into the experimental room and were seated at the test table. The experimenter handed the infant a series of small rubber warm-up toys to play with while explaining the general procedure to the parent. When the infant seemed acclimated to the room and experimenter, which usually took about 1–3 min, the warm-up toys were withdrawn and the test began.

Subjects were randomly assigned to one of three test conditions: baseline control ($n$ = 12), adult-manipulation control ($n$ = 12), and imitation ($n$ = 12). Within each condition the stimuli were presented in six different orders, and across these orders each stimulus occurred once in each test position. One male and one female infant were assigned to each order within each condition; thus sex of infant and test order were completely matched among the experimental and two control groups (2 sexes × 6 orders = 12 subjects per test condition).

**First session—**In the imitation group each subject was sequentially shown the six target acts (object pulling, hinge folding, button pushing, egg rattling, bear dancing, and head touching). The acts were shown one at a time in one of the predetermined test orders. Each object was kept hidden in a container below the experimenter's chair before it was brought to the table for its demonstration and returned to the container before the next object was presented. Each demonstration consisted of a 20-s period in which the target act was repeated three times. For example, the experimenter leaned forward and touched the panel with his forehead and then straightened up, repeating his action three times in the 20-s stimulus-presentation period.

The demonstrations were presented on the tabletop just out of reach of the subject so that he or she could not touch or play with the toy, but was confined to observing the event. If the infant became distracted during the presentation, the experimenter would call the child's name, say "look over here," or "oh, see what I have," but would never use words relating to the task such as "touch head," "imitate," or "copy."

The procedure for the baseline control was similar to that just described. Parents and subjects were first escorted to the waiting room to complete forms. They were next led to the test room, where they sat at the table. Again the experimenter spoke to the parent while handing warm-up toys to the child until he or she seemed acclimated. The difference

[1]The issue of what constitutes a novel act is a complex one without unanimous agreement among theorists. This issue is analyzed in detail in the Discussion section. Suffice it to note here that the head-touch act occurred with a zero spontaneous probability among over two dozen infants in pilot studies. As a first approximation, this served as an operational definition of novelty.

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between the imitation and baseline conditions was that in the latter the subjects were neither exposed to the toys nor to adult modeling on the first session.

I have previously argued that the most stringent test of imitation requires more than a simple baseline control with which to compare the imitation group (Meltzoff, 1988a). Infants in the imitation condition see the experimenter pick up and manipulate the test objects; they also see that the objects have properties—that they beep, rattle, light up when touched, and so forth. It is possible that seeing the adult handle the test objects and/or that simple exposure to the special properties of the objects motivates infants to manipulate the objects when they are subsequently presented. Such active, exploratory manipulation might in turn lead the infants to produce the target actions by chance. Such an effect could well be characterized as “social facilitation” or “stimulus enhancement” rather than imitation (Meltzoff, 1988c). The baseline control does not provide an assessment of this type of nonimitative production of the target actions. An additional control is useful—one that involves the same experimenter handling the same six test objects but without exposing infants to the specific target actions under test.

In the second control, the adult-manipulation condition, the subjects were exposed to a series of six stimulus-presentation periods. For each presentation the experimenter reached out and manipulated the test object; as in the experimental group the presentation lasted 20 s, and as in the experimental group the control displays were demonstrated three times in the 20-s period. Each control display was carefully designed to mimic distinctive features of the experimental display.

For the light panel, the experimenter touched his hands to the sides of the box and illuminated the panel via a foot switch, thus mimicking the effect achieved when the experimenter touched it with his forehead. For the pull-toy, the experimenter held the already separated object by the two end pieces and moved them up and down, spanning a linear extent that matched the horizontal movement of pulling the object apart. For the beeper box, the experimenter touched the sides of the box with his hands and surreptitiously used his finger to activate a small switch that set off the beeper. For the hinge toy, the infants were shown that the small flap could move relative to the wooden base. This was accomplished by using an object identical to that used in the experimental condition but without the hinge attached. Infants saw the object with the flap already placed in a horizontal position (the “end-state” for the flap in the imitation group), and the flap was then moved toward the infant and back while being held between the experimenter’s thumb and forefinger. The forward and backward movement approximated the distance traversed by the are of the flap in the imitation condition. For the rattle, the experimenter held his palms facing each other on the table (28 cm apart) and pushed the plastic egg back and forth so that it rattled as it slid. Finally, the bear was placed flat on the table and spun in a circle using the thumb and index finger.

Although no significant differences in the production of the target behavior between the baseline and adult-manipulation conditions were necessarily predicted (Meltzoff, 1985, 1988a, used similar control groups and found no differences), both were used because they provided complementary controls. The baseline condition assessed the chance probability

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that subjects would produce the target behavior on their own without previously having been exposed to the toys or actions modeled. The adult-manipulation control assessed the degree to which subjects were induced to perform the actions for nonimitative reasons, that is, merely as a result of seeing the adult reach out and touch the test stimuli and/or because they experienced the beeps or rattles of the test objects. Using this design, the inference of imitation was warranted if subjects differentially produced more of the specific target acts after seeing those acts modeled than in the two controls.

**Second session—**For all three test conditions a 1-week delay was interposed between the first and second sessions (*M* = 7 days, *SD* = 1.8 hr). Subjects in all three conditions were treated identically on the second visit. The infants were led into the experimental room and seated at the table, and the experimenter again provided warm-up toys for about 1–3 min, until the subject was acclimated. At that point the warm-up toys were removed and the test objects were presented in their original test order. Each object was placed on the table directly in front of the infant. The response period for each object was 20 s, starting from the moment that the infant first made contact with the toy. The response period was electronically timed and video recorded for subsequent scoring. For infants in all three test conditions the rattling material was removed from the opaque egg to protect against the possibility that it might acidentally make noise when simply touched by the infant (and not shaken) in the second session. Similarly, the light panel was deactivated so that it did not automatically illuminate to touch. These safeguards prevented any accidental cuing of the infants in the second session that might have arisen from their perceiving inadvertent rattling sounds or lights. It is possible that infants in the imitation group expect the egg to make a sound when shaken, but this would not have distorted the results, because the first shaking motion was the only action scored. The same applies for the light panel.

## Scoring

The video records of the response periods for the experimental and control infants were identical in that all infants had a series of six 20-s response periods. Thus, there were no artifactual cues on the video record as to whether the infant had been exposed to the target action. A scorer who was naive to group assignment viewed these records and provided a dichotomous yes/no code as to whether the infant produced the target action with each object, and if so the latency. The operational definitions for the “yes” codes were the following. The infants were scored as producing an act of head touching if they leaned forward and touched the panel with the forehead. Pilot studies had revealed that some 14-month-old infants, especially those who were bundled up in bulky overalls or sweaters, would sometimes lean forward and strain to touch the panel with their heads but were physically unable to make contact. Therefore, a “yes” code was also scored if the infant leaned forward toward the panel, strained to touch it, and missed contact by no more than about 10 cm. Pull apart was scored if the dumbbell-shaped toy was pulled apart into two pieces. Hinge fold was scored if the infant folded the vertical piece through an are of at least 45° toward the baseplate. Button push was scored if the infant poked the button far enough to activate the beeper. Egg shake was scored if the infant shook the object, where “shake” was defined as a brief bidirectional movement in which the trajectory retraced itself. The

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dancing bear was scored if the infant picked up the bear and suspended it by the string or jiggled the object so that it “danced” on the tabletop.

Both intra- and interobserver reliability were assessed, the latter by having two independent observers score all the subjects and the former by having a randomly selected 25% of the subjects rescored by one observer. Scoring reliability was high as assessed both by using the percentage of agreement and the kappa statistic (kappa is an index of agreement ranging from 0 to 1 that incorporates a correction for chance; Applebaum & McCall, 1983; Cohen, 1960). These methods yielded the following values, repectively: for intraobserver, 1.0 and 1.0; for interobserver, .99 and .96.

## Results

Each subject was presented with six test stimuli and thus was assigned a score ranging from 0 to 6 according to the number of target behaviors produced. The results were analyzed using a 3 (condition) × 2 (sex) analysis of variance (anova). The main effect for condition was significant, $F(2, 30) = 12.00$, $p < .001$. There was no main effect for sex, $F(1, 30) = 0.76$, and no Condition × Sex interaction, $F(2, 30) = 0.44$. A follow-up Newman-Keuls test showed that infants in the imitation condition produced significantly more target behaviors ($M = 3.42$, $SD = 1.08$) than those in either the baseline ($M = 1.25$, $SD = 0.97$) or the adult-manipulation controls ($M = 1.67$, $SD = 1.30$), *p*s < .05. There was no significant difference in the number of target behaviors produced by the two controls.

The strength of the imitation effect is clearly seen in Table 1, which provides a raw data matrix of the number of target acts performed as a function of experimental treatment, $\chi^2(10, N = 36) = 24.46$, $p < .01$. As shown, 11 of the 12 subjects in the imitation condition duplicated three or more target behaviors, whereas only 3 of the 24 control subjects did so, $p < .0001$, using the Fisher exact test, thus providing clear evidence for the modeling effect.

Did infants imitate the novel behavior of touching the light panel with their foreheads? Table 2 presents the data individually for each of the six test objects as a function of experimental condition. The data support the notion that leaning forward to touch the panel with one’s head was legitimately a novel act in as much as none of the 24 control infants did so. Nonetheless, 8 of the 12 infants who saw this behavior reproduced it themselves, $p < .0001$, using the Fisher exact test. The target act of pulling apart the dumbbell toy was also performed infrequently by the controls (20.8%), and significantly more often in the imitation group (83.3%), $\chi^2(1, N = 36) = 10.41$, $p < .005$. The button pushing was performed at a consistently high rate by infants in all groups. Thus, although 83.3% of the infants who saw button pushing produced this act, this high response cannot be considered imitative because it occurs almost that often in the controls. Conversely, jiggling the bear by the string was performed at a consistently low rate by all groups and was not discriminative. The hinge folding and egg shaking fell somewhere between, showing trends toward discriminable behavior as a function of treatment; a larger number of subjects would be necessary to reach significance for each of these acts considered in isolation.

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Infants in the imitation condition differed from the controls in a qualitative way that went beyond the fact that they were producing more target behaviors. It appeared that they directly and confidently set about producing the target actions when given the test objects during the second session. The qualitative observations were converted into a quantitative measure by calculating each subject's mean latency to produce the target action (mean latency is the sum of each subject's latencies divided by the number of targets that he or she produced). These data were analyzed using a 3 (condition) × 2 (sex) anova. The main effect of condition was significant. $F(2, 25) = 4.66$, $p < .05$, and neither the main effect of sex, $F(1, 25) = 1.37$, nor the Condition × Sex interaction, $F(2, 25) = 0.13$, reached significance. A follow-up Newman-Keuls test showed that the target actions were produced with significantly shorter latencies in the imitation condition ($M = 2.33$ s, $SD = 2.26$) than in either the baseline ($M = 7.45$ s, $SD = 4.26$) or the adult-manipulation control ($M = 5.70$ s, $SD = 4.70$), $p$s < .05. The scores in these controls did not differ significantly from each other. These latency data provided further evidence for the long-term effect of modeling and lent support to our impressions that infants in the imitation condition produced the targets more directly or intentionally than did those in the controls.

## Discussion

The results of this experiment show that deferred imitation of multiple displays occurs by 14 months of age. This effect does not appear to be confined to a few children of this age, for 92% of the infants in the imitation condition (11 of 12) duplicated three or more displays after the 1-week delay, whereas this level of target production was rare in the controls, exhibited by only about 13% of them.

An important aspect of this experiment is that the subjects were limited to observing the targets on the first session; they were not allowed to imitate immediately or even to handle the toys at that time. In home interactions infants often imitate online, repeating a vocalization or toy manipulation in mutual imitation with the mother, later repeating this same act without further modeling. Such an effect is worthy of study and is certainly impressive for parents themselves, but cognitive-developmentalists have argued that retaining a memory of one's own previously enacted imitation is an easier task than initiating imitation for the very first time after a delay (McCall et al., 1977; Meltzoff, 1985, 1988a; Piaget, 1962). In particular, Piaget (1962) argued that the preservation and reduplication of an already performed motor pattern could occur earlier than in the 18- to 24-month age range that he estimated for the onset of deferred imitation proper. In the present study I respected this theoretical distinction and assessed infants who had been deprived of the opportunity for immediate imitation.

The delay period of 1 week qualifies as a strong demonstration of deferred imitation and greatly exceeds the retention intervals previously tested in imitation in preverbal children. The number of different acts retained after the delay is also noteworthy. The modal response was for infants to duplicate three of the six acts after the 1-week delay, and 2 infants kept in mind and repeated five of them. It is somewhat surprising that so many different acts could be entered into memory for readout 1 week later, especially in view of the fact that each demonstration lasted only 20 s. The laboratory findings reported here provide a strong

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warrant for investigating the role of imitative processes in everyday interactions, because brief displays, multiple acts in sequence, and even the modeling by nonattachment figures do not seem sufficient in themselves to prevent the adult's behavior from serving as a model for the infant observer.

The imitation of novel acts has historically been a cornerstone in developmental debates. It is traditionally assumed that novel acts, just because they are novel, are qualitatively more difficult to imitate than are familiar ones (Masur & Ritz, 1984; Piaget, 1962; Uzgiris & Hunt, 1975). However, on the basis of the present study, one would not want to conclude that the imitation of novel acts as a *general class* is necessarily more difficult than the imitation of familiar ones. Head touch was imitated, and the impression gained was of infants equally or more engaged by this task than by others. Quizzical frowns at the demonstration and smiles and triumphant looks upon successful imitation were observed. Although admittedly speculative, it is worth suggesting that in certain cases a novel or unusual display may actually serve to heighten imitation. Indeed novelty and the length of delay may interact. Seeing an unfamiliar person perform an unusual act may stand out in memory and be less likely to be interfered with than are more familiar events.[2]

The data indicate that the 14-month-olds in this test exhibited deferred novel imitation without a period of trial-and-error in the second test session. For the children who imitated the head-touch gesture, the mean latency was 3.21 s. The inference is that, on seeing the demonstration in the first session, infants were able to represent the act in long-term memory even though it was not a standard, habitual game (e.g., pat-a-cake or sliding a block on the table). In Piagetian terms, infants were able to accommodate their mental schemes internally without motor practice or directed groping on the task. That the delay interval was 1 week effectively rules out any type of temporary "motor set" or nonrepresentational explanation for what these children did.

For discussion purposes, the head-touch act has been categorized as novel, in part because the behavior had a zero probability of occurrence in the baseline and control conditions—that is, the data clearly showed that head touch was not a habitual, high-baseline-rate behavior of the infants. From a more analytic perspective, however, it may be useful to differentiate several different meanings associated with the notion of behavioral novelty, all of which are worth investigating alone and in interaction. An act can be novel in at least the following six senses: (a) it has not been seen or heard by the infant before, (b) it has not been performed before, (c) although possibly performed "in passing," it has not become a familiar, well-practiced game for the infant (a Piagetian "circular reaction"), (d) it has not been imitated by the infant before, (e) a behavior has not previously been put in relation with a particular object or class of objects before (in the sense that pretending to drink from a calculator is a "novel act"), and (f) it occurs with near-zero probability in spontaneous play during a baseline period.

[2]The argument here is not the converse of the prevailing view, namely that novel behaviors are *always* more likely to be imitated after a delay than are familiar behaviors. Rather my argument is that (a) in some cases unusual events may be retained and imitated with facility and (b) the determinants of deferred imitation are more complex than the simple rule that there is a negative association between degree of novelty and likelihood of long-term deferred imitation.

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Piaget offered as a paradigmatic case of novel imitation the duplication of “crossing and uncrossing my arms and hitting my shoulders with my hands (the movement one uses to get warm)” (Piaget, 1962, p. 62, Observation 51). It would be difficult to argue that this behavior is novel in the sense of Criterion a (mentioned above) or even Criterion b, but a stronger case could be made for its being novel in the sense of Criteria c, d, and f. Similarly, Masur and Ritz (1984) interviewed parents and asked if an individual child had developed a game of performing an act such as “hitting blocks together.” If the child did not have such an act as part of his or her regular routine it was scored as a “novel item”; if a parent had regularly observed the act it was termed “familiar” for the child. This approach also leans heavily on Criteria c–f. Uzgiris and Hunt (1975) used the same type of procedure to isolate gestures that were “unfamiliar” to individual infants (such as “blinking eyes”), and imitation of them was then considered an indication of advanced development. Finally, Killen and Uzgiris (1981) argued that familiar acts (such as drinking from a cup) were imitated as early as 10 months but that meaningless acts (such as “drinking” from a car or “driving” a block) were first imitated at 22 months of age.

The present study changes the empirical picture somewhat by showing that the head-touch gesture, which fits well within the senses of novelty described in Criteria c–f above, nonetheless was imitated even after a lengthy delay by infants as young as 14 months of age. These data suggest that it is not a universal rule that novel acts, as a broad and general class, are poorly imitated until very late in infancy. Whether this deferred novel imitation is limited only to acts involving objects or whether pure body movements (Meltzoff & Moore, 1977, 1983) might likewise be imitated remains to be investigated; more generally, the question becomes one of the boundary conditions of the imitation reported here. Given the results and conceptual analysis presented in this article, it would now be useful to investigate systematically the six senses of novelty outlined above using a variety of different types of acts both immediately and after delays.

Even without this further work these data are relevant to developmental theories, because deferred imitation of any type of behavior, and especially the deferred imitation of novelty, is often depicted as part of a general representational shift at about 18 to 24 months of age that includes deferred imitation, object permanence, the insightful use of tools, symbolic play, and productive language (Flavell, 1985; Piaget, 1954, 1962; Smolak, 1986). However, no studies indicate that large numbers of children can solve the most advanced type of object permanence tests by 14 months of age (Harris, 1987), and few suggest so for insightful tool use or productive language. These results, therefore, suggest that long-term deferred imitation develops well before these other abilities, which are commonly conceived of as contemporaneous (“Stage 6”) psychological achievements tapping the same underlying representational abilities. There may be a distinction between representing a now-absent act (deferred imitation) and representing a particular object in a location after it has undergone disappearance/reappearance transformations (object permanence); future work might usefully probe how such representational activities may or may not relate to each other and to other significant psychological achievements at the end of infancy (e.g., symbolic play, tool use, language). Recently, we have begun to investigate these questions about developmental interrelations (Gopnik & Meltzoff, 1986, 1987; Meltzoff, 1988b, in press).

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Beyond these complexities, it is worth noting that tests of deferred imitation afford a direct and valuable assessment of memory in preverbal infants. As such they complement and extend two other techniques often used for investigating infant memory. One such technique involves assessing infants' retention of a conditioned response (foot kicks) after a delay (Rovee-Collier et al., 1980). Deferred imitation differs from such tests because the link between the stimulus and the infant's response is not forged through conditioning; in the deferred imitation procedure, the infant does not act on the objects in the first session, and thus no extrinsic reinforcement for producing the target response is possible. Moreover, the two tests differ in the content of the retained information. Whereas in the conditioning technique infants demonstrate the retrieval of their own previously enacted motor behavior, deferred imitation is not based on the repetition of one's own previous actions but on the reproduction of an act that was merely visually perceived. The deferred imitation paradigm also complements and broadens the type of information garnered from visual recognition memory tests (Cohen & Gelber, 1975; Fagan, 1970, 1973). In deferred imitation, infants go beyond receptive skills; they do more than recognize a pattern as similar to a previous exposure. In the case of deferred imitation, infants must *produce* an absent act without now seeing it and without having previously imitated it—they must generate the necessary act themselves on the basis of memory. Deferred imitation thus measures something more akin to recall or cued-recall memory rather than simply recognition. Others have called for tests of infant recall so that its development may be compared with recognition memory (Flavell, 1985; Moscovitch, 1984); tests of deferred imitation would be useful in this regard.

In sum, the present findings strongly suggest that imitation is well-enough articulated to play an important role in early learning and development. Theories of social and cognitive development will need to take into account that infants' behavioral repertoire and knowledge about objects may develop not only through maturation, adult shaping, and solitary discovery, but also through direct imitation of acts that they observe in their cultural milieu. The results show that infants are able to internally represent the acts that they see adults perform and are motivated to use these representations to guide their own subsequent behavior, even after the intervention of lengthy delays.

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**Table 1**

Number of Subjects Producing Different Numbers of Target Acts as a Function of Test Condition

| | *N* target acts | | | | | | |
|---|---|---|---|---|---|---|---|
| **Test condition** | **0** | **1** | **2** | **3** | **4** | **5** | **6** |
| Baseline control | 3 | 4 | 4 | 1 | 0 | 0 | 0 |
| Adult-manipulation control | 2 | 4 | 4 | 0 | 2 | 0 | 0 |
| Imitation | 0 | 1 | 0 | 6 | 3 | 2 | 0 |

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**Table 2**

Proportion of Subjects Producing Each Target Act as a Function of the Test Condition

| | Test condition | | |
|---|---|---|---|
| **Target act** | **Baseline (*n* = 12)** | **Adult-manipulation (*n* = 12)** | **Imitation (*n* = 12)** |
| Head touching | .000 | .000 | .667 |
| Object pulling | .167 | .250 | .833 |
| Button pushing | .667 | .750 | .833 |
| Egg shaking | .083 | .083 | .250 |
| Hinge folding | .333 | .417 | .750 |
| Bear dancing | .000 | .167 | .083 |
| *M* | .208 | .278 | .569 |