

Peer Imitation by Toddlers in Laboratory, Home, and Day-Care Contexts: Implications for Social Learning and Memory

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Three experiments examined peer imitation with 14- to 18-month-old infants. In Experiment 1, infants saw a trained 14-month-old ("expert peer") perform specific actions on 5 objects. Imitation from memory was tested after a 5-min delay. In Experiment 2, the infants observed an expert peer in the laboratory, and retention and imitation were tested in the home (change of context) after a 2-day delay. In Experiment 3, a peer demonstrated target acts at a day care, and after a 2-day delay infants were tested in their homes. Results from all 3 experiments showed significant imitation compared with controls. The experiments demonstrate social learning from peers during infancy and also provide the first evidence for infant imitation from memory across a change in context.

One of the realities of infant day care is that infants are increasingly spending time with peers (Howes, 1991; Scarr, Phillips, & McCartney, 1990). Does infant peer interaction have an impact on development? Evidence for the influence of peer interaction on emotional development was presented some time ago by A. Freud and Dann (1951) and Harlow (1969), who demonstrated the ameliorating effect of peers for human infants and infant monkeys separated from their mothers. These researchers established that infants can develop beneficial relationships with one another, using each other for emotional security in extraordinary circumstances.

There is a growing consensus that meaningful social interactions occur among infant peers in everyday encounters. Research has shown that infants treat peers as social partners (Field, 1979) and that young infants react positively to peers and will match a peer's rhythm of interaction (Hay, Nash, & Pedersen, 1983). Infants have been reported to be more social with unfamiliar peers than with unfamiliar adults (Lewis, Young, Brooks, & Michalson, 1975) and to have higher proportions of mutual social interaction with same-age peers than with older siblings (Vandell & Wilson, 1987). By the end of the first year,

infants exhibit turn-taking skills with one another (Ross & Lollis, 1987), and in the second year, toddlers develop the ability to play coordinated games with one another (Howes, 1988). Howes also found that toddlers are influenced by being in stable peer groups and developing familiar routines with one another, inasmuch as toddlers who came from stable groups exhibited more complex play behavior and social competence with new peers in preschool. Rather than the competence with peers depending exclusively on earlier interactions with adult caregivers, it is possible that competence with peers and competence with adults develop simultaneously (Field & Roopnarine, 1982; Hay, 1985; Rubin & Ross, 1982).

Infants pay attention to one another and influence each other's behavior, and one of the ways they influence one another is through imitation of each other's actions. Meltzoff (1985b, 1990a) has shown that mutual imitation between two partners is a principal mechanism for interpersonal communication in infancy, before language. His work has demonstrated that infants show a special sensitivity to having their behavior reflected back to them by adults—they smile more and look more at an adult who is imitating their behavior. Related effects have been reported among toddlers. Toddlers use imitation as a basic way to interact and develop social and communicative ties with one another (Eckerman, Davis, & Didow, 1989; Eckerman, Whatley, & Kutz, 1975; Howes, Unger, & Seidner, 1989; Nadel-Brulfert & Baudonnière, 1982). Observations of peer interaction have shown that toddlers develop reciprocal imitative games in which imitation of a gesture leads to its repetition and then yet another instance of imitation, in a kind of nonverbal conversation (Eckerman & Stein, 1982). These imitation games serve to keep toddlers engaged with one another (Eckerman & Stein, 1990) and may foster a sense of social connection with the peer (Asendorpf & Baudonnière, 1993; Nadel & Fontaine, 1989). Infants similarly use imitation in social interaction with adults (Eckerman, Whatley, & McGehee, 1979; Meltzoff & Moore, 1992; Uzgiris, 1981).

Much of the past work on infant peer interaction has focused on the social-communicative aspects of imitation, but work using adults as models has also shown that there is a cognitive side to imitation. For example, previous research using adults as

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models has established deferred imitation in toddlers, which implicates the ability to recall the observed behavior at a later time. Meltzoff (1988c) demonstrated that 9-month-old infants can perform deferred imitation of a perceptually absent model after a 24-hr delay interval. Meltzoff (1988b) showed that 14-month-olds can imitate highly novel acts even after a delay of 1 week. Bauer and Mandler (1992) reported imitation of multi-step event sequences in 1-year-olds, and Bauer and Hertsgaard (in press) have documented conditions, such as the familiarity and coherence of the event, that facilitate memory for events across delay intervals. Furthermore, research has shown that toddlers can transfer their learning from a two-dimensional display to three-dimensional objects by imitating an action they saw on a television screen (McCall, Parke, & Kavanaugh, 1977; Meltzoff, 1988a). Most recently, there have been efforts to bridge the gap between the interpersonal-communicative and cognitive aspects of infant imitation by comparing the efficacy of mothers versus strangers as models for eliciting imitation (Meltzoff & Moore, 1992) and, at a more theoretical level, by analyzing the possibility that infant imitation serves as a key developmental foundation for the emergence of a "theory of mind" (Meltzoff & Gopnik, 1993). These experiments coalesce to suggest that infant imitation is a powerful tool for learning about oneself, other people, and how to use objects in the world.

The available data indicate that there is a strong proclivity in infants to imitate the particular acts and skill-oriented object manipulations of adult models. Are infants more highly constrained in the type of things they pick up from watching each other's actions, perhaps being limited to immediate mimicry of familiar actions? A few observational studies have reported that more of infant peer imitation (as compared with imitation of adults) is vocal, affective, and gross-motor rather than skilled actions with toys (Bakeman & Adamson, 1984; Brenner & Mueller, 1982; Kuczynski, Zahn-Waxler, & Radke-Yarrow, 1987). As in Piaget's (1962) example of deferred imitation of a peer (Jacqueline copying a temper tantrum she had observed earlier in a playmate), a conservative prediction from these studies might be that infants predominantly retain from their peers simple, fairly nonspecific behavior (Turkheimer, Bakeman, & Adamson, 1989; see also Abramovitch, Corter, & Lando, 1979). However, naturalistic observations such as these may not have been adequate to assess the nature and specificity of what can be retained from peer observation and reproduced in subsequent deferred imitation. One experimental study of peer imitation reported more deferred imitation of actions on toys using a televised 2-year-old model than when using live adult models (McCall et al., 1977). This raises the intriguing possibility that infants can learn and remember over time the specific object-related behaviors of their peers.

In the three experiments reported here, our goal was to test the nature and extent of toddlers' ability to imitate specific actions on objects that they had seen demonstrated by their infant peers. Experiment 1 used procedures and stimuli similar to Meltzoff's (1985a, 1988b) previous experiments using adults as models but substituted a same-age peer for the adult model. Experiment 2 tested deferred imitation and the generalization of peer imitation by changing the procedure in two significant ways: (a) inserting a 2-day delay between the time an infant

observed a peer model and was subsequently tested for imitation and (b) changing the context between the demonstration and test phases by conducting peer modeling in the laboratory and testing imitation in the subjects' homes. Experiment 3 tested for deferred peer imitation in a "real-world" setting by arranging for peer modeling within the context of infant day-care centers and testing subjects for imitation in their homes. Such memory and transfer of imitative learning from peers, if it could be demonstrated, would have substantial implications for theories of social and personality development.

Experiment 1

Method

Subjects. The subjects were sixty 14-month-old infants who had been recruited by telephone from local birth announcements. Subjects' families were primarily White and middle class. Infants were admitted into the experiment if they were free of any known physical or mental handicaps and had a normal length of gestation (37–43 weeks) and a normal birth weight (2,500–4,500 g). The mean age at the time of test was 14.0 months, ranging from 13.7 months to 14.3 months. Equal numbers of male and female infants were tested, with equal numbers of male and female infants observing male models and equal numbers observing female models. Each subject was assigned to one of five random orders of presentation of the stimuli (2 sexes \times 2 sexes of models \times 5 orders = 20 subjects in each of three experimental conditions = 60 subjects). Fifty-six subjects were accompanied by their mothers during testing, and 4 by their fathers. An additional 11 infants were tested but could not be used (2 for parents' interference, 4 for experimenter error, and 5 for the expert peer refusing to demonstrate all the target acts).

Test environment and apparatus. All testing took place in a small room containing only the equipment and furniture necessary for the experiment. During the procedure, the infant subject sat on his or her parent's lap across a small table from a female adult experimenter. A video camera behind and to the left of the experimenter was focused on the subject. A second camera behind and to the left of the subject was focused on the expert peer, who also sat on his or her parent's lap at one end of the table.

Stimuli. The stimuli used in this experiment were five objects either constructed in the laboratory or adapted from store-bought items. The first object was a dumbbell-shaped object 12.5 cm long made of small wooden cubes with plastic tubing attached. One piece of tubing was narrower and fit inside the other. The demonstrated or target act was to grasp the object by the wooden cubes on each end and pull it apart. The second object was a collapsible plastic cup 6.5 cm high made of a graded set of plastic bands. The target act was to collapse the cup by pushing down on the top with a flat hand. The third object was a buzzer hidden inside a black box (5.4 \times 15 \times 16.5 cm). The top of the box was sloped so that subjects could easily view a single small hole (1.5 cm in diameter) in the surface. The target act was to activate the buzzer by poking a finger through the hole. The fourth object was a 21-cm strand of pink beads presented with a yellow plastic cup 9.5 cm high, with an opening 6.5 cm in diameter. The target act was to pick up the beads by one end and place them inside the cup. The fifth object was a triangular wooden block with a 30-cm length of string attached to its base. The target act was to pull the block along the table by pulling the end of the string.

Procedure. The first step in the procedure was the training of a 14-month-old infant so that he or she could become the "expert peer" and demonstrate the target acts to the naive peer subject. This infant was selected from the group of subjects on the basis of characteristics such as congeniality and responsiveness to adults, and he or she was

then trained to be an expert peer as follows. The adult female experimenter brought the infant into the testing room with his or her parent and demonstrated the target act on each object. The experimenter then placed each object in front of the infant, one by one, and if imitation occurred, the infant was praised amply. The object was taken away and brought back for a second try, and then a third. The goal was to develop a routine in which the expert peer readily performed the target act on each object. Each infant serving as an expert peer was expected to demonstrate for up to 3 subjects. The expert peers' parents (primarily mothers—only one father accompanied an expert peer) were requested to remain at the laboratory for up to 2 hr and were paid \$15 for this service. The expert peers were free to use a playroom or explore the building in between their scheduled demonstrations.

Infant subjects, on arriving at the laboratory with their parents, were escorted to a waiting room where they could play with toys and meet the expert peer while the parents filled out consent and information forms. After 10–15 min, the subject came with his or her parent to the testing room. There the adult experimenter interacted with the subject by handing him or her rubber toys to explore until the infant seemed comfortable with the experimenter and the room. This warm-up phase usually lasted 1–3 min.

In the *peer model* condition ($n = 20$), the experimenter then signaled for the expert peer to enter with his or her parent. The experimenter began by placing the first object in front of the expert peer and prompting him or her to begin the routine they had previously established. The objects were demonstrated in one of five random orders, across which each object occurred in every possible position. The infant subject was prompted to pay attention to the peer demonstration by the experimenter, who periodically made comments such as "Look at that" and "Did you see that?" and praised the subject for watching. Care was taken to avoid using any verbal description of the target action being tested; the language was used only to draw the subject's attention to the display. Once the demonstration was over, both infants left the room for a 5-min delay. The expert peer went into a room next to the testing room, and the infant subject either returned to the waiting room or walked in the hallway. Thus the 2 infants were separated during the delay. After 5 min, the infant subject returned to the testing room with his or her parent and the adult experimenter. The expert peer was absent during the deferred imitation test. The experimenter now placed the five objects, one at a time in the order of their demonstration, in front of the infant subject to see if he or she would reproduce the target acts. Subjects were given 20 s from the moment they first touched an object to produce a response; thus the data for analysis consisted of five 20-s response periods from each subject.

In the *baseline control* condition ($n = 20$), the procedure differed from the peer model condition only by the omission of the peer demonstration. The goal of the baseline control condition was to assess whether infants would spontaneously produce the target acts in the absence of seeing any peer modeling. These infants participated in the warm-up with the adult experimenter, left the room for the 5-min delay, then came back in for the test with the five objects. Thus the data from subjects in the baseline control condition also consisted of five 20-s response periods.

As suggested by Meltzoff (1985a), an additional control is useful for assessing imitation that goes beyond the traditional baseline condition. Infants in the peer model condition have a different experience than the baseline control because they are in the presence of another child. Watching another child play with a toy may have arousal effects on the observer or may even increase the desirability of the toy and lead to a more thorough exploration of what the toy can do. A stricter control would involve equating for such nonimitative peer effects. Toward this end, we used a *control peer* group. The goal of the control peer condition was to assess whether simply observing a peer manipulate the objects would increase the likelihood of a subject spontane-

ously producing the target acts. In this condition ($n = 20$), peer demonstrators were chosen on the same basis as in the peer model condition. However, during the training, the experimenter demonstrated an alternative act (not the target act) on each object and then placed each in front of the peer demonstrator. The experimenter praised the infant as long as he or she consistently picked it up and manipulated it without performing the target act. The procedure for subjects in the control peer condition was identical to the peer model condition. Infant subjects participated in the warm-up with the adult experimenter, then the peer demonstrator came in with his or her parent and went through the routine previously established. Both infants left the room after the demonstration and were separated for the 5-min delay, then the infant subjects came back in for the test with the five objects. Thus the data from subjects in the control peer condition also consisted of five 20-s response periods.¹

Scoring. Subjects' videotapes were edited into a random order with only the 20-s response periods and no indication of which condition the subject had participated in. These edited tapes were scored by observers who were unaware of the assignment of particular subjects to either the model or the two control conditions. Observers coded dichotomous yes/no scores for target acts on each object. The pulley was scored as a "yes" if it visibly separated. The collapsible cup was scored as a "yes" if it was collapsed at least halfway without being thrown or banged. The buzzer was scored as a "yes" if the buzzing sound could be heard. The pink beads were scored as a "yes" if they were placed at least halfway inside the cup. The string was scored as a "yes" if the block moved along the table at least half the length of the string. Each subject's responses were tallied across toys to yield a single score: the total number of target acts produced by that subject (range of 0–5).

To assess intra- and interobserver reliability, one observer coded all subjects, then recoded half that were randomly selected. A second observer coded two thirds of the data. Intra- and interobserver reliability on subjects' scores were evaluated with Pearson r (.94 and .95, respectively) and kappa coefficients (.83 and .86, respectively). Intraobserver agreement was 100% on the beads ($\kappa = 1.0$); 96% on the pulley and the buzzer ($\kappa = .92$); 93% on the cup ($\kappa = .83$); and 86% on the string ($\kappa = .58$). Interobserver agreement was 100% on the pulley, the buzzer, and the beads ($\kappa = 1.0$); 92% on the cup ($\kappa = .82$), and 85% on the string ($\kappa = .65$).

Results and Discussion

The results provide strong evidence for peer imitation. Subjects in the peer model condition produced on average 64% of the target acts that they were shown. Table 1 presents the frequencies of subjects' scores in the peer model versus the two control conditions. The mean score for subjects in the peer model condition was 3.20 ($SD = 1.01$). The mean score for subjects in the baseline control condition was 0.90 ($SD = 0.85$), and the mean score for subjects in the control peer condition was 0.90 ($SD = 0.97$). A 2 (sex) \times 3 (experimental condition) analysis of variance (ANOVA) yielded a significant main effect for experimental condition, $F(2, 54) = 41.04$, $p < .001$; no significant effect for sex, $F < 1.0$; and no significant Sex \times Experimental Condition interaction, $F(2, 54) = 2.41$, $p > .10$. A follow-up Tukey honestly significant difference test revealed significant differences between the peer model condition and each of the two control conditions ($p < .05$); the two control conditions were not significantly different from each other. A nonparamet-

¹ Subjects in the control peer condition were tested at a later date than subjects in the peer model and baseline control conditions.

ric analysis of experimental condition also yielded significant results, Kruskal-Wallis $\chi^2(2, N = 60) = 29.78, p < .001$.²

The data for each separate toy are displayed in Table 2 along with chi-square statistics. Comparisons of the number of subjects in each condition who performed the target act on each toy again revealed significant differences between the responses of the peer model condition versus the controls for four out of the five toys, $\chi^2(2, N = 60), p < .001$ in each case. The string toy was the only toy that failed to distinguish between subjects who had observed the demonstration and those who had not. (The target act on the string toy was the most difficult to train: The expert peers frequently pulled the string only in order to then dangle the block in the air, resulting in an unclear demonstration.)

A 2 (sex of subject) \times 2 (sex of peer model) \times 2 (experimental condition: expert peer vs. control peer) ANOVA revealed a significant main effect for experimental condition, $F(1, 32) = 58.78, p < .001$, with no significant main effects for sex of subject ($p > .10$) or sex of model ($p > .50$). None of the interactions were significant ($p > .10$), save for a trend toward an Experimental Condition \times Sex of Model interaction ($p < .06$).³ Correlational analyses comparing number of subjects' siblings and amount of peer experience (which was categorized as the number of days in a week that the infant spent time with others of the same age) with subject's scores within the peer model condition yielded nonsignificant results ($ps > .50$).

The results of this experiment show that when 14-month-old infants watch another infant perform specific actions on toys, they are stimulated to do the same thing. The controlled, laboratory setting ensured that the infants were limited to observing the peer with no possibility of engaging in concurrent imitation (subjects were not given the toys to handle during the peer demonstration itself), and yet the 14-month-olds readily imitated actions with toys even after a 5-min memory delay. The infants were not simply exploring the objects as a result of seeing a peer play with them (a kind of "stimulus enhancement"), because the expert peer condition differed significantly from the control peer condition. Moreover, the subjects in the control peer condition produced no more of the target acts than the baseline control subjects. The findings demonstrate that infants imitate the specific object manipulations they see performed by their peers and that such imitation effects can occur on the basis of memory for the absent peer's behavior.

Experiment 2

Experiment 1 shows that infants can imitate their peers even after a 5-min delay. However, for peers to serve as powerful

Table 2

Number of Target Acts Produced on Each Stimulus as a Function of Condition (Laboratory Experiment)

Condition	Stimuli				
	Pulltoy	Buzzer	Cup	Beads	String
Baseline control	2	3	2	7	4
Control peer	3	4	0	6	5
Peer model	15	17	10	17	5
$\chi^2(2, N = 60)$	23.55*	25.42*	17.50*	14.80*	0.19

* $p < .001$.

models for social learning and development, the observer infant must be able to imitate over longer delays and also be able to generalize across contexts. In Experiment 2, we tested deferred imitation of peers by using the same demonstration paradigm but increasing the delay interval to 48 hr and, more significantly, introducing a change in context. In the second experiment, infants were shown what to do by peers in the laboratory setting, but they were then presented with the toys at their homes (change of context) by a second adult who had not been in the lab on the first day. This provided a strong test of the ability of infants to learn from their peers and transfer that learning across time and space.

Method

Subjects. The subjects were sixty-four 14-month-old infants who had recruitment and admission procedures similar to the first experiment. Subjects' families were primarily White and middle class. The mean age at the time of test was 14.0 months, with a range of 13.7 months to 14.2 months. Equal numbers of male and female infants were tested, with equal numbers of male and female infants observing male models and equal numbers observing female models. Two subjects of each sex were assigned to one of four random orders of presentation of the stimuli (2 subjects \times 2 sexes \times 2 sexes of models \times 4 orders = 32 subjects in each of 2 experimental conditions = 64 subjects). Fifty-seven subjects were attended to by their mothers during testing at home, 5 by their fathers, and 2 by alternative caregivers. An additional 22 infants were tested but could not be used (2 for parents' interference, 2 for caregivers' not being available after the 48-hr delay for the follow-up visit, 7 for experimenter error, and 11 for the expert peer refusing to demonstrate all the target acts).

² As noted earlier, 5 subjects had been dropped from the study because the expert peer refused to demonstrate all five toys. For the purposes of completeness, their data were also analyzed. They produced on average 69% of the target acts they had seen, which is not significantly different from the 64% produced by subjects in the peer model condition.

³ We do not have a good explanation for this trend. It resulted from the fact that subjects in the peer model condition produced somewhat more target acts after observing a male peer demonstrator ($M = 3.50$) than after observing a female peer demonstrator ($M = 2.90$), whereas subjects in the peer control condition produced somewhat fewer target acts after observing a male ($M = 0.60$) than after observing a female ($M = 1.20$) demonstrator.

Table 1

Number of Target Acts Produced as a Function of Condition (Laboratory Experiment)

Condition	No. of target acts produced						Total <i>n</i>
	0	1	2	3	4	5	
Baseline control	7	9	3	1	0	0	20
Control peer	9	5	5	1	0	0	20
Peer model	0	2	2	6	10	0	20

Test environment and apparatus. Testing occurred both at the lab and in the subjects' homes. The test environment at the lab was identical to that previously described. Testing at home took place around a kitchen or dining room table, wherever it was convenient for the parent to have the infant sit on his or her lap across a table from the experimenter. The infant subject was videotaped at home for subsequent scoring by using a portable video camera set on a tripod.

Stimuli. The stimuli used in this experiment were the same objects as the previous experiment except for the string toy, which had failed to elicit an imitative response. The remaining four were used for demonstration and testing: the pulltoy, the collapsible cup, the buzzer, and the beads.

Procedure. The procedures for selecting and training expert peers, initial greeting and warming-up subjects, and demonstrating target acts for subjects in the peer model condition were identical to those used in the previous experiment. All expert peers were accompanied by their mothers.

For subjects in the peer model condition ($n = 32$), the lab procedure ended after the peer demonstration. The subjects left the laboratory without ever having handled the four test toys. Two days after their lab visit, the infant subjects were visited at home by a second female experimenter, whom they had never seen before and therefore was not associated with either the lab or the toys in the infant's mind. The first female experimenter arranged for home visits with the parents and gave the schedule to the second experimenter without informing her of the subject's experimental condition. The change in experimenter reduced the number of contextual cues available to the subjects for memory retrieval. The new experimenter arrived in a marked university vehicle and carried portable video camera equipment, which she set up while introducing herself to the parents and reminding them of the procedure. The home test began with the brief warm-up. The toys used in the warm-up period at the home were plastic rattle-type toys instead of the rubber ones at the lab. This change also reduced contextual cues. The adult experimenter then placed the four test objects, one at a time in the same order in which they were demonstrated, in front of the infant subject to see if he or she would reproduce the target acts. For each toy, subjects were given 20 s from the moment they first touched an object to produce a response. Thus the data for analysis consisted of four 20-s response periods from each subject.

In the control condition ($n = 32$), the procedure differed from the imitation condition only by the omission of the peer demonstration. These infants participated in the warm-up with the first experimenter and then went home. Two days later they were visited at home by the second experimenter and presented with the four objects so that we could assess whether infants would spontaneously produce the target acts without having observed them being modeled. Although data from Experiment 1 indicated low rates of such spontaneous production in the laboratory, it was conceivable that the home context would change those rates, being a more familiar and comfortable setting in which to explore toys. There was no basis for using an additional control peer group in Experiment 2, because Experiment 1 had shown no increase in spontaneous production of the target acts over the baseline group from observing a peer manipulate the objects; moreover, a 48-hr delay between observing the peer and being tested was likely to diminish any nonspecific arousal effects from merely being exposed to the peer 2 days earlier.

Scoring. Scoring was identical to that in Experiment 1: Observers who were unaware of the assignment of subjects to either the model or control condition coded edited tapes of the 20-s response periods. Intra- and interobserver reliability on subjects' scores from a randomly selected half of the data were evaluated with Pearson r (.99 for both) and kappa coefficients (.98 for both). On individual item data, inter- and intraobserver agreement were both 100% for all the stimuli except the cup, for which both inter- and intraobserver agreement were 97% ($\kappa = .91$).

Results and Discussion

The results showed that infants imitated their peers after the 48-hr delay. Subjects who observed a peer demonstration produced on average 52% of the four target acts. Table 3 displays the number of target acts produced by the experimental and control subjects. The mean score for subjects in the peer model condition was 2.09 ($SD = 1.23$). The mean score for subjects in the control condition was 0.94 ($SD = 0.95$). A 2 (sex) \times 2 (experimental condition) ANOVA yielded a significant main effect for experimental condition, $F(1, 60) = 18.16$, $p < .001$; no significant effect for sex, $F(1, 60) = 2.24$, $p > .10$; and no significant interaction effect, $F(1, 60) = 1.07$, $p > .30$. A nonparametric analysis of experimental condition also revealed a significant difference between the peer model and control conditions, Mann-Whitney $U = 241.5$, $p < .001$. A 2 \times 2 ANOVA within the peer model condition comparing sex of subject with sex of peer model yielded no significant main effects or interactions ($ps > .10$), and correlational analyses yielded no significant effects for siblings or peer experience ($ps > .50$).⁴

These results provided a strong demonstration of peer influence in infancy. This second experiment showed that infants can encode an action performed by another infant, retain it for 48 hr, and use it in a different context. In this experiment, the infants demonstrated a transfer of learning across context. The only visual cues for remembering were the toys themselves—the experimenter was different, the environment was different, and even the toys used in the warm-up were different.

One question to ask at this point is whether the increased memory delay and change in context weakens memory for imitation. Previous work by Meltzoff (1985a, 1988c) found no significant difference between immediate and deferred imitation using a 24-hr delay, when context was held constant and both the demonstration and the imitation test were assessed within the same laboratory setting. To address the possibility of forgetting in the present experiments, we reanalyzed the data from Experiment 1 using only the four toys used in Experiment 2 so that we could directly compare the two sets of results. In Experiment 1, with the 5-min delay and no change of context, infants in the peer model condition produced an average of 2.95 target acts out of 4 possible. In contrast, infants in Experiment 2, after a 48-hr delay and a change in context, produced 2.09 target acts out of 4. This difference reaches significance, $t(50) = 2.62$, $p < .05$ and Mann-Whitney $U = 193.0$, $p < .05$. (Infants in the baseline control condition in Experiment 1 produced 0.70 target acts, which is not significantly different from the 0.94 of the baseline control in Experiment 2, $p > .30$.) Thus, there was less of an imitative response over the change in context and lengthened delay. However, imitation was still robust under these conditions. Although this experiment cannot determine whether the 48-hr delay or the shift in context is primarily responsible for the decreased response, it does show that neither delay nor

⁴ Eleven subjects were dropped from the study because the expert peer refused to demonstrate all four toys. For the purposes of completeness, their data were also analyzed. They produced on average 55% of the target acts that they had seen, which is not significantly different from the average of 52% produced by subjects in the peer model condition.

Table 3
*Number of Target Acts Produced as a Function of Condition
 (48-Hour Delay and Change of Context Experiment)*

Condition	No. of target acts produced					Total <i>n</i>
	0	1	2	3	4	
Control	12	13	4	3	0	32
Peer model	3	8	9	7	5	32

context change erases the infant's recall of peer-demonstrated behavior. The deferred imitation of peer actions can be generalized across contexts early in the second year of life.

Experiment 3

Experiment 1 and Experiment 2 combined demonstrate the ability of 14-month-old infants to remember and reproduce actions modeled by a peer both after a 5-min delay and after a 48-hr delay. For the third experiment, we were interested in whether infants could perform deferred imitation of their peers when the target behavior was observed in a real-world setting, such as a day-care environment, and needed to be retrieved and used later in a different context, at home. Such findings would suggest that deferred imitation is not only a laboratory phenomenon but that it can be used by infants to learn from peers in distracting real-world environments.

Method

Subjects. The subjects were 18 toddlers who were recruited from area day-care centers through letters to parents given out by the day-care directors. The mean age at the time of test was 16.7 months, ranging from 14.6 months to 18.1 months. The increased age range used in this experiment allowed recruitment of groups of subjects from each day-care center. Subjects' families were primarily White and middle class. Recruitment difficulties with children in day care necessitated a smaller sample size and uneven distribution of sexes: 10 male and 8 female toddlers. Fourteen subjects were attended to by their mothers during testing at home, and 4 by their fathers. An additional 2 toddlers were tested but were eliminated from the experiment because the expert peer refused to model the toys.

Test environment and apparatus. The demonstration occurred at the subjects' day-care centers, and testing occurred at their homes. At the day-care centers, subjects sat around a table they normally used for group meals or activities. For the subsequent test of imitation at home, subjects sat on their parents' laps at a kitchen or dining room table. Subjects were videotaped at home, as described in the previous experiment.

Stimuli. The stimuli used in this experiment were the same four objects as in Experiment 2: the pulltoy, the collapsible cup, the buzzer, and the beads.

Procedure. The expert peers for this experiment were selected from the group of infants who had demonstrated the target acts for subjects in Experiment 2. Three children served as expert peers in day-care centers, 2 boys and 1 girl (age range = 20.6–29.0 months, $M = 25.9$ months). They visited the laboratory to be retrained with the same procedure as the previous experiments; once they had satisfactorily completed the retraining, arrangements were made for a day-care demonstration. The first female experimenter went to the expert peer's

home on the day of the day-care visit, briefly ran through the procedure with the 2-year-old expert, and then escorted the expert with his or her parent to the day-care center. At the center, the expert peer played with the group in the room to adjust to the new surroundings, after which he or she performed the target acts on the four toys. The expert peer's parent was given \$10 for participating on each occasion. On all occasions, expert peers were accompanied by their mothers.

Once parents had returned a form indicating interest in the experiment, arrangements were made for subjects in the peer model condition ($n = 9$) to observe a demonstration at their day-care center. When the experimenter arrived with the expert peer, all of the toddlers in the room were brought to the table by their teachers and given rattles to play with. Once the toddlers were seated, the rattles were put away, and the expert peer sat at the table and performed the four target acts. All of the toddlers were directed to watch the demonstration. After the demonstration, the toddlers left the table and engaged in normal day-care activities for the rest of the day. The experimenter took the expert peer and his or her parent home.

Two days after the day-care demonstration, subjects were visited at home by the second female experimenter who had not been present at the day-care visit. The parents also had not been present at the day-care visit and were not told of the nature of the target acts, further reducing cues available to the subject. The second experimenter tested subjects for imitation in a manner identical to that described for Experiment 2.

We tested subjects in the baseline control condition ($n = 9$) at home as in Experiment 2 to assess whether they would spontaneously produce the target acts without having seen them being modeled. These subjects were also enrolled in participating day-care centers but never observed a day-care demonstration. Day cares involved in the experiment had been randomly assigned to provide subjects for either the imitation or the control condition. Six infant day-care centers were involved in the experiment. They received \$10 gift certificates to a local children's bookstore for each subject they contributed.

Scoring. Scoring was identical to that in Experiments 1 and 2. Two observers coded all trials; one observer recoded all trials. Interobserver and intraobserver agreement were both 100% on all data.

Results and Discussion

The results provide clear evidence for deferred imitation of peers in a day-care setting. Subjects who observed a day-care demonstration produced on average 72% of the four target acts. Table 4 compares subjects' scores of number of target acts produced in each condition. The mean score for subjects in the peer model condition was 2.89 ($SD = 0.78$). The mean score for subjects in the control condition was 1.00 ($SD = 1.12$). The difference between these distributions of scores was significant, $t(16) = 4.15$, $p < .01$ and Mann-Whitney $U = 8.0$, $p < .01$.

In this experiment, toddlers imitated the specific actions on objects demonstrated to them by a child model in their day-care center after a 2-day delay and a change of context. These

Table 4
*Number of Target Acts Produced as a Function
 of Condition (Day-Care Experiment)*

Condition	No. of target acts produced					Total <i>n</i>
	0	1	2	3	4	
Control	4	2	2	1	0	9
Peer model	0	0	3	4	2	9

findings provide direct evidence that young toddlers in day-care centers can perform deferred imitation of those around them. Even within a group setting and distracting environment, toddlers are able to encode their observations of peers' behaviors and subsequently perform their imitation across a substantial delay and change in context.

Because the stimuli and delay were identical, we can compare the scores of infants in the peer model conditions of Experiment 2 and Experiment 3. In Experiment 2, infants observing a demonstration in the laboratory produced on average 2.09 of the target acts when tested at home 2 days later. In Experiment 3, infants observing a demonstration in their day-care center produced on average 2.89 of the target acts when tested at home 2 days later. The difference between these means approaches significance, $t(39) = 1.83$, $p < .08$ and Mann-Whitney $U = 88.5$, $p < .09$. The average subject in Experiment 3 was 2 months older than the subjects in Experiment 2, suggesting that there may be developmental changes in imitating, observing peers, or retrieving memories of absent events over a change in context.

General Discussion

The research reported here extends the previous laboratory studies on infant imitation by using peers as models and including tests of infants in real-world settings—at home and in day care. Experiment 1 established a technique of using an expert peer demonstrator. Five minutes after observing the demonstration, subjects produced a significantly greater number of the target acts than other groups of subjects who either observed a peer play in alternate ways with the same toys (control peer condition) or observed no demonstration (baseline control). Experiment 2 provided evidence that infants who observed a peer demonstration in the laboratory could perform deferred imitation after a 2-day delay and a change of context to their own home. Experiment 3 moved the procedure completely out of the laboratory and showed that toddlers could observe a demonstration at their day-care center and perform deferred imitation 2 days later in their own home.

These experiments are the first to test whether infants could remember a previous demonstration across not only a temporal delay but also a change in context. Such deferred imitation across a context shift would seem to be important if imitation is to have long-lasting influences on infant learning and development. For deferred imitation to be used in everyday life, infants must be able to pick up information at one point in time, transfer the learning to a new setting, and act on it when the appropriate situation arises.

Recent research on memory in infancy has found strong influences of context on memory in young infants (Rovee-Collier, 1990). It was discovered that 3-month-old infants failed to retrieve a conditioned response to a familiar stimulus when a contextual cue was changed, specifically when they were tested in a different room (Rovee-Collier & Hayne, 1987) and that 6-month-old infants' memory was significantly impaired by a contextual change as simple as a differently patterned crib liner (Shields & Rovee-Collier, 1992). These studies found that the 6-month-olds were even more contextually bound than 3-month-olds, and the researchers hypothesized that as infants

become more aware of the environment, they rely more on contextual cues as a guide for what behavior is appropriate in individual settings. Linking a behavior to a distinctive context in memory guards against inappropriate retrieval. This view of the adaptive nature of contextually bound information fits well with research on the effects of context in learning in animals (Balsam & Tomie, 1985) as well as research on discrimination learning in children (Campione & Brown, 1974). Consistent with Rovee-Collier's research, it has been hypothesized that one reason for the inability of adults to remember events from infancy ("infantile amnesia") is the vast change in context from an infant view of the world to an adult view. In one of the few examples of an ability in young children to recall an early experience, Perris, Myers, and Clifton (1990) brought 2-year-olds back to a laboratory setting that they had experienced as 6-month-olds and found evidence of recall for the actions the children had originally performed. They attributed this finding to a very careful reconstruction of the original context. Also using conditions in which the encoding and recall contexts were carefully arranged to be as identical as possible, Meltzoff (1988b) found that 14-month-old infants could accurately duplicate a completely novel action they had observed a week before. More recently, Meltzoff (1993) used deferred imitation as a tool for assessing even longer term memory and for exploring "infantile amnesia" effects. In this study of imitation, the encoding occurred at 14 months of age and the recall occurred 4 months later, at 18 months. Again, the context remained the same, and the results showed no "amnesia" for the target actions despite the shift from a largely preverbal to postverbal representational status over this age span (see Meltzoff 1990b, 1993, for further discussion).

It is also of interest that the 14-month-olds' recall was reduced by a combination of a change in context and lengthened delay. In Experiment 2, the scores from subjects tested in their own homes were significantly lower than scores from subjects tested in the laboratory in Experiment 1. However, unlike the 6-month-olds in previous work, the 14-month-olds' recall was not profoundly dampened by the change in context over a delay. These toddlers were able to generalize their memory for imitative acts. There are at least two large differences between Rovee-Collier's work and ours that may account for the very different findings about the effects of change of context on preverbal memory. First, the difference in ages of the subjects may be suggestive of a developmental trend in the ability to retrieve target information across changes in context between the encoding and recall site. Such "decontextualization" will become important in language learning at about the 14-month-old age range we tested (e.g., Barrett, 1986; Nelson & Lucariello, 1985). Second, imitation of another's behavior may draw on different mechanisms than conditioning, with information that has been acquired through observational learning more easily transferred from one setting to another. Observational learning and imitation will be most adaptive if behaviors that are "picked up" from peers and adults can be transported in time and space and deployed in novel contexts. The evolutionary history of such imitative learning is of substantial interest (Tomasello, Kruger, & Ratner, in press).

Deferred imitation studies are also relevant to current debates in cognitive psychology and neuroscience about *multiple*

memory systems. It has been proposed that there are dissociable memory systems that have different neural bases and developmental time courses (e.g., Diamond, 1990; Schacter & Moscovitch, 1984; Sherry & Schacter, 1987; Squire, 1987; Tulving, 1985). One distinction that is commonly drawn is between an early-developing procedural memory system (habits and conditioned responses in which learning gradually occurs over repeated trials) and a later-developing memory system (in which learning occurs with a single exposure and information can be retained without motor practice on the task). A much discussed developmental question is whether preverbal infants are limited to a procedural or habit memory—which might be seen as roughly akin to Piaget's (1952) *sensorimotor schemes*—or whether some higher order memory is available in the preverbal period (Mandler, 1990; Meltzoff, 1985a, 1990b; Rovee-Collier, 1990).

For reasons elaborated elsewhere (Meltzoff, 1985a, 1988b, 1990b), the deferred imitation procedure is thought to tap something beyond a purely procedural or habit memory, because the modeling occurs in one brief episode and the infants are not allowed to touch the toys or practice the target acts before the test for imitation. The infants in the experiments reported here did not learn to perform the target acts by emitting behavior that was subsequently reinforced. In our test paradigm, subjects were not allowed to touch or handle the toys until the recall test, up to 2 days after the demonstration. Infants had no chance to learn these acts through incremental trials. They learned simply by observing a peer in a single brief episode. The results of imitation after a delay under these conditions and across changes in context offer support for the hypothesis that preverbal infants can access a nonhabit or nonprocedural memory system. Meltzoff and Moore (1992, in press) have recently provided data on imitation from memory in 6-week-olds, suggesting that some sort of nonhabit memory is available from the earliest phases of infancy, although this core ability undergoes important changes with age (Meltzoff, 1990b).

The present research also addresses issues of a social nature. It contributes to the literature on early peer interaction by suggesting that child-child play may be more than solely an affective interchange and that imitative learning of specific acts may occur. A concrete example was provided by the 19-month-old son of one of the authors. He had not shown much interest in his father's juggling clubs. Then, after observing toddlers use toy bowling pins to play baseball at day care, he came home and began to bat tennis balls with his father's juggling clubs. Without any prompting, he spontaneously transferred his imitative behavior to the home setting and to different stimuli. In the everyday world, it seems likely that toddler attention to peers and their affective attitudes toward them combine with imitative proclivities to exert influences on toddler behavior.

Observations of infants and toddlers show how attracted they are to peers, slightly older children, and older siblings, and there are a variety of ways that this affects social-cognitive development (Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Dunn & Kendrick, 1982; Kuczynski et al., 1987; Rogoff, 1990; Tomasello et al., in press; Zukow, 1989). The sense of being imitated by a social partner has dynamics of its own, leading to attraction to the imitator and repetition of the imitated actions (Eckerman & Stein, 1990; Meltzoff, 1990a). This has been hy-

pothesized to be a building block for treating others as "like self" and a fundamental component in the development of a "theory of mind" (Meltzoff & Gopnik, 1993). Within this framework, it is of interest that research in theory of mind is beginning to uncover individual differences as a function of interactive experience and whether the subjects have siblings (Dunn et al., 1991; Perner, 1993). Peer imitation may play a special role in sex role development. Preference for same-sex adult models has been demonstrated in studies with preschool-age children (e.g., Bussey & Bandura, 1984; Slaby & Frey, 1975), and preference for affiliation with same-sex peers has been observed in 2-year-olds (La Freniere, Strayer, & Gauthier, 1984). If imitation of peer models has the long-term effects on behavior that have been suggested here, then imitation and affiliation may be intertwined in fostering some of the gender-related behaviors that begin to be evident at this age. We intend to investigate this possibility using the peer imitation procedure developed in these three experiments to explore the role of same-sex peer imitation in the development of sex-stereotyped behavior. This line of research should give new insights into the many dimensions of peer interaction and imitation in infancy and early childhood.

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