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Keywords
models, infant, imitation, televised, peer, adult

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Key words: Imitation, learning, behavioral recall, age-related changes, television, peer vs. adult model

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Abstract

Developmental changes in learning from peers and adults during the second year of life were assessed using an imitation paradigm. Independent groups of 15- and 24-month-old infants watched a pre-recorded video of an unfamiliar child or adult model demonstrating a series of actions with objects. When learning was assessed immediately, 15-month-old infants imitated the target actions from the adult, but not the peer whereas 24-month-old infants imitated the target actions from both models. When infants' retention was assessed after a 10-minute delay, only 24-month-old infants who had observed the peer model exhibited imitation. Across both ages, there was a significant positive correlation between the number of actions imitated from the peer and the length of regular peer exposure reported by caregivers. Length of peer exposure was not related to imitation from the adult model. Taken together, these findings indicate that a peer-model advantage develops as a function of age and experience during the second year of life.

Peers can have a powerful influence on the behavior of children. For example, in naturalistic play settings, 4- to 11-year-old children copy up to 19 behaviours per hour from their peers (Abramovitch &

Grusec, 1978). Despite the prominent role peers may play in the lives of children, the ontogeny of this influence is not well understood. In the present study, we examined 15- and 24-month-old infants' imitation of actions demonstrated by an adult or by a similar-aged peer. The purpose of this research was to address two key questions. First, do peers and adults have a similar, or different, level of impact on the behaviour of children in the first years of life? Second, does the effectiveness of a peer "teacher" vary as a function of the amount of experience infants have had interacting with their own age group?

In the first months of life, infants are able to imitate simple gestures demonstrated by another person (e.g., Meltzoff & Moore, 1977, 1983; Nagy & Molnar, 2004). This early imitative response is thought to help the infant explore and establish similarities between themselves and the other person (Meltzoff, 2005, 2007). In contrast, 5- to 8-week-old infants do not imitate gestures demonstrated by inanimate objects (Legerstee, 1991), suggesting that even very young infants respond differently to different types of models. In general, infants appear to be more responsive to, and interactive with, social stimuli compared to non-social stimuli (e.g., Johnson, Dziurawiec, Ellis, & Morton, 1991; Legerstee, Pomerleau, Malcuit, & Feider, 1987). For example, 8-week-old infants show discriminative patterns of vocalisations, looking, and smiling when encountering an inanimate doll versus their own mother or a female stranger (Legerstee et al., 1987).

When infants are interacting in social situations, they do not respond equally to everyone (Fogel, 1979; Brooks & Lewis, 1976). For example, 1- to 3-month-old infants systematically change their behavior depending on whether they are alone, with an unfamiliar peer, or with their mother (Fogel, 1979). Over the course of infancy, peers appear to play an increasingly central role on infants' actions. In a study of the play behaviour exhibited by 10- to 24-month-old infants, Eckerman, Whatley, and Kutz (1975) observed that play with mothers decreased and play with peers increased as a function of age. The nature of peer interactions themselves also changes during the second year of life. In a longitudinal study, Eckerman, Davis, and Didow (1989) observed that 16-month old-infants who encountered a peer interacting with an object primarily played alongside that peer. Infants at this age tended to move towards the peer and to interact with the same play material. By 24 months of age, however, infants increasingly coordinated their actions with those being performed by the peer and began to engage in sustained social games. The increase in coordinated actions reflected an increase in non-verbal imitation of the peer's actions, rather than an increase in verbal communication.

Peer imitation in early childhood is usually followed by positive consequences, such as an increase in social interactions (Grusec & Abramovitch, 1982). Similarly, a potential explanation proposed by Eckerman et al. (1989) to account for the increase of peer imitation in the second year of life is that infants might have learned "specific strategies of actions that increase the likelihood of valued interactive events" (p. 451). From this perspective, imitating another peer's actions might be a particularly adaptive way of bonding with them, possibly reducing the amount of uncertainty about the other infant and their interactions (cf. Uzgiris & Kruper, 1992). It is possible that infants may require regular peer contact to learn to use imitation as a pathway to positive social interactions with a peer.

In fact, there is evidence that infants' behavior towards peers changes as a function of experience with other infants (e.g., Becker, 1977; Mueller & Brenner, 1977; Roopnarine, 1985; Roopnarine & Field, 1983). For example, Roopnarine and Field (1983) found an increase of proximity- and contact-seeking behaviors in infants and toddlers after a semester of nursery school attendance. Mueller and Brenner (1977) also reported that daily contact to peers over several months played a significant role in toddlers' ability to sustain social interactions with their peers. The authors suggested that parallel play using toys might serve as a trigger for the development of peer social relations. Extensive peer exposure thus appears to be associated with enhanced social skills. Furthermore, there is some experimental evidence that increased exposure to a peer leads to changes in social interactions with same-aged infants in general. In a study with 9-month-old infants, the number of actions directed towards a peer increased with the number of times an infant had encountered this peer (Becker, 1977).

This change in behavior was also stable across a change in social context: When encountering a novel peer, infants exhibited the same high level of peer-directed action that they had shown towards the familiar peer after numerous encounters. It thus appears that prolonged contact to peers lastingly alters the nature of infants' interactions with peers they know *and* peers they encounter for the first time. Assuming that attention to a model and the willingness to interact are necessary preconditions for successful imitation, it seems possible that infants who have had increased experience with peers, for example through regular nursery or playgroup attendance, might show higher rates of imitation from a peer in comparison to infants with less previous peer exposure.

In comparison to infants' peers, adults have additional means of communicating with an infant such as through language (Holmberg, 1980). Adults naturally use child-directed language when addressing an infant, and will actively initiate interactions with infants in the second year of life more often than peers do (Holmberg, 1980). Even though imitation might be part of these exchanges, there is some suggestion that in naturalistic settings imitation might be more frequently used amongst familiar infant-dyads than between mothers and infants, at least when both the peer and mother are present (cf. Rubenstein & Howes, 1976). Given differences in the social interaction methods of infants compared to adults, a social-developmental perspective might predict that a peer model would elicit higher rates of imitation from an infant in the second year of life than an adult model.

As recently suggested by Hay, Caplan, and Nash (2009), little is known about the underlying cognitive and learning processes of early peer relations, and there is a need to integrate findings from the literature on social and cognitive development. Imitation is often conceptualised as serving both a social and a cognitive function (Uzgiris, 1981). In addition to allowing non-verbal communication and interaction, imitation provides infants with the opportunity to acquire novel behaviors. In their home environment, infants in their second year of life acquire 1 – 2 novel behaviors per day by observing and copying other people (Barr & Hayne, 2003). Thus, an increased tendency to imitate their peers might not only reflect a gain in infants' social skills, but also an improved ability to acquire knowledge from other children. Rubenstein and Howes (1976) proposed that similar sensorimotor and cognitive skills might mean that infant peers share interests and pleasures when interacting with toys. By imitating each other, infants might acquire novel skills with inanimate objects and peer imitation is thought to be reinforced through the pleasure of a shared activity that both members of the dyad enjoy equally. Eckerman et al. (1975) suggested that in addition to peers' actions being more novel to infants, they might be more easily duplicated than actions from adults. In terms of memory processes, it could be speculated that the peers' actions might be more easily encoded as they match the way infants themselves would carry out these actions. In other words, the cognitive load may be reduced when observing a peer. This, in turn, may result in a fuller memory representation of the actions being encoded and stored for later retrieval.

Most of the work on peer learning has focused on observations of naturally occurring imitation. In the present study, we sought to study imitation using a more controlled experimental paradigm that would enable us to draw a direct comparison of learning and remembering novel actions from a peer versus an adult model. The ability to reproduce novel actions another person has performed with an object is central to a well-established method for examining learning and memory during infancy, deferred imitation (for review, see Hayne, 2004; Jones & Herbert, 2006). In a typical imitation procedure, the infant observes a series of actions performed by an unfamiliar adult with novel objects (e.g., Hayne, Boniface, & Barr, 2000), although familiar adults (e.g., Devouche, 2004) and peers (e.g., Hanna & Meltzoff, 1993) can also be effective demonstrators. For example, in Hanna and Meltzoff (1993), 14- to 18-month-old infants saw an "expert" 14-month-old peer demonstrating a series of one-step actions with objects. Infants' ability to reproduce the target actions was assessed either 5 minutes or 2 days later. Infants in the demonstration groups showed significant levels of imitation after both delays compared to infants in control conditions who had not seen a demonstration of the target actions. These findings confirm that early in the second year of life infants learn and remember the actions that a peer demonstrates in an experimental setting.

Only a few imitation studies to date have considered the effectiveness of peer compared to adult demonstrations. Across those studies there has been little consistency in the methods or findings. Evaluating the imitation of a simple facial gesture, Abravenel and DeYong (1997) observed no difference in 13- to 23-week-old infants' learning from a televised peer compared to an adult. However, in this study, the peer model was a cartoon-style character while the adult model was a recorded real-life person. This discrepancy impairs direct comparisons between the effectiveness of the two models. McCall, Parke, and Kavanaugh (1977) investigated 1- to 3-year-old children's imitation of actions with objects from televised peer and adult models. However, in this study peer and adult models were used in different experiments, using different stimuli, and the results were not directly compared. Thus, the knowledge gained about the effectiveness of peers versus adults in these early studies is limited.

To date, only one published study has directly compared the effectiveness of peer and adult models on infants' imitation of actions with objects. In Ryalls, Gul, and Ryalls (2000), 14- to 18-month-old infants had the opportunity to interact with a 3-year-old child or an adult who subsequently demonstrated a series of three-step sequences with objects. Infant imitation was assessed immediately and 1 week after the demonstration. When tested immediately, there was a small but significant difference in the number of target actions reproduced following a peer demonstration (M = 2.28) compared to an adult demonstration (M = 1.92). Although both groups showed evidence of retention after a one-week delay, there was no difference in target actions imitated as a function of model. At both time points, however, infants who had watched peer demonstrations showed a small but significant enhancement in ordered recall, producing more target actions in the same sequence as they had been demonstrated, compared to infants who had watched an adult demonstration.

The findings from Ryalls et al. (2000) provide the first suggestion that some aspects of learning and memory may be enhanced when 14- to 18-month-old infants' observe a demonstration from a peer. It is important to note, however, that adults played an important role during all the demonstration and test sessions in this study. In both the peer and adult conditions, an adult experimenter narrated the actions to the observing infant, handed the stimuli to the infants, and provided a verbal prompt during the test. Given that adult-provided language cues facilitate retention in imitation tasks (e.g., Hayne & Herbert, 2004), it is not clear to what extent these cues might have interacted with infant learning in the two demonstration conditions. Furthermore, the models themselves were not present at the 1-week test, which was conducted by an adult experimenter. It is possible that the discrepancy between conditions at encoding and retrieval may have impacted on task performance at the delay test, potentially minimising any group differences. Finally, this study did not address the possibility of age-related changes in imitation from peer and adult models as their experimental groups consisted of infants ranging in age from 14- to 18-months, an age range that covers important transition times in the development of peer interactions (e.g., Eckerman et al., 1989).

The purpose of the present study was to examine age-related changes in infant imitation from peer and adult demonstrations during the second year of life and to consider whether individual differences in peer experience outside the experimental situation might contribute to differences in learning and memory. Given that there is an age-related increase in peer imitation in naturalistic settings (Eckerman et al., 1989), a peer model advantage might be expected to be strongest towards the end of infancy. Therefore, we hypothesised that older infants would show higher rates of imitation from a peer demonstration than an adult demonstration. To evaluate the impact of the different-aged models on learning and memory, imitation was assessed immediately or after a 10-minute delay. Previous imitation research has shown that different encoding experiences can affect memory after this delay interval (e.g., Hayne et al., 1997; Jones & Herbert, 2008). Given that age-related differences in retention have been observed in some imitation studies even though there were no differences in initial levels of encoding (e.g., Herbert & Hayne, 2000a), no predictions were made with regards to the timing of when (immediate, after a delay) a peer-model advantage might be observable. Furthermore, given that peer contact is crucial for the development of social interactions with peers (e.g., Mueller & Brenner, 1977), there might also be individual differences in infants' imitation from peers as a function of length of regular peer contact. Therefore we hypothesised that, within an age, infants with more experience with peers would show higher rates of imitation from peers.

The methodological difficulties of ensuring that a young child (the "expert" peer) will present a consistent imitation performance for each participating infant has previously been discussed by Eckerman and her colleagues (Eckerman & Didow, 1989; Eckerman & Stein, 1990). Therefore, we presented the peer and adult demonstration on a pre-recorded video, similar to McCall et al. (1977). This presentation method guaranteed identical demonstrations for each participant and provided the opportunity to match the adult demonstration as closely as possible to the peer demonstration in terms of timing and social cues. Although infants learn less from a televised demonstration than from a live demonstration (e.g., Barr & Hayne, 1999; Barr, Muentener, & Garcia, 2007a; Barr, Muentener, Garcia, Fujimoto, & Chavez, 2007b; Hayne, Herbert, & Simcock, 2003; Troseth, 2003), infants as young as 6-months can imitate the actions they have seen demonstrated on television (e.g., Barr et al., 2007a). Given that there may be considerable individual variation in infants' exposure to television as well as to peers, parental reports were obtained on the amount of television viewing infants' engaged in and the frequency of attendance at nursery or playgroup.

Method

Participants

The final sample consisted of 120 infants who participated within 2 weeks of turning 15 (*n* = 60) or 24 months of age (*n* = 60). All infants were full-term ($\geq$ 37 weeks) and typically developing. They were drawn form a pool of volunteers recruited in the neonatal unit of a local hospital. Fifty-eight infants were female and 62 infants were male. Information on the infants' ethnicity was available for 77.5% of the sample. Of these infants, 94.6% were Caucasian, 2.2% Asiatic, 1.1% Asian, and 2.2% African-Caucasian. Information on maternal education was available for 72.5% of the sample. The highest educational qualification reported by the maternal caregiver was: secondary education (GCSE's; 6.9%), further vocational qualifications after secondary education (18.4%), A-Levels (qualification to enter University in the UK; 9.2%), university degree (42.5%), and postgraduate qualification (23%).

Twelve additional infants were excluded due to maternal interference with the procedure (*n* = 2), experimenter error (*n* = 1), infant's refusal to watch the video (*n* = 2) or failure to interact with the stimuli (*n* = 4), or fussiness during the session (*n* = 3).

<u>Materials</u>

Two videos were created for the experimental groups. In each video, a model demonstrated a sequence of three target actions to create a rattle. The actions were demonstrated three times in succession. The age of the model varied as a function of experimental group: either a 2-year-old girl, or a female adult. Both the peer and the adult were unfamiliar to the infants in this study. To ensure there was no difference in the verbal information provided in the two videos, language cues were not used during the demonstration. The rate of the demonstration in the adult video was matched as closely as possible in timing to the peer video. The duration of the peer video was 99s. The duration of the adult video was 95s.

The stimuli for constructing a rattle (see Herbert & Hayne 2000a, b) consisted of a green stick (12.5 cm long) attached to a white plastic lid (9.5 cm in diameter), with Velcro attached to the underside of the lid; a round green block (3 cm in diameter x 2.4 cm in height); and a clear plastic square jar with Velcro around the top (5.5 cm in diameter x 8 cm in height). The opening of the plastic jar (3.5 cm in diameter) was covered with a 1-mm black rubber diaphragm, with 16 cuts radiating from the centre.

To ensure that children in the baseline group also observed a video of stimuli being constructed, two additional videos were created, one with a 2-year-old girl as the model and one with an adult female as the model. In each video, the model demonstrated a sequence of three target actions with stimuli unrelated to the present experiment (a soft toy that could be stuck together in sections with Velcro). Thus, even though infants in the control groups went through a very similar procedure as infants in the experimental groups, they had not encountered the model or stimuli prior to test. Previous imitation studies (e.g., Meltzoff, 1988) have shown that baseline control groups, where infants do not see the stimuli before test, provide a more conservative measure of the spontaneous production of actions than control groups where the experimenter touches or manipulates the test stimuli without performing the target actions. However, it is also possible that simply observing another person, particularly a peer, interacting with objects may encourage infants to engage in more exploration of the stimuli they themselves encounter at the test session. Providing infants in control groups with the opportunity to watch an unrelated video prior to their test session created an additional control against this possibility.

Two questionnaires were developed to determine the amount of television and peer experience at each age. In the *Television Viewing* questionnaire, caregivers were asked whether their child watched television/videos. If they answered yes, they were asked to estimate the amount of time the infant spent watching television in a typical week and how much of this time they watched on their own compared to watching with their caregiver. Caregivers were also asked to estimate the amount of attention the infant paid to the television during their viewing. All questions were presented in a multiple choice format. In the *Peer Contact* questionnaire caregivers were asked if their child attended a nursery or playgroup. If they answered yes, they were asked to provide information about the amount and frequency of attendance. Information about whether the child had any older siblings was also collected.

Procedure

Infants were tested at the University of xxx infant lab. On arrival, the purpose of the study was explained to the caregiver and informed consent was obtained. When the infant appeared comfortable, the experimenter accompanied the caregiver and infant to the experimental room.

Demonstration session: The caregiver and infant sat on a floor cushion in front of a TV (50 cm screen), approximately 1.5 m from the screen. The experimenter sat beside them. Half the infants in the demonstration groups watched the peer video, and half the infants watched the adult video (n = 24 per demonstration video at each age). If the infant failed to orient towards the screen, the experimenter pointed to the screen saying "Look, what's that?" but did not label the event or the target actions. Caregivers were requested not to provide any prompts to their infants. Infants in the delay groups left the room after watching the demonstration video and returned to the reception area.

For infants in the baseline control group (n = 12 infants per age), this initial session was identical with the exception that the video they watched was unrelated to the target stimuli that would be presented at the test session. Half the infants in the baseline group at each age watched a peer video and half watched an adult video. All demonstration sessions were video recorded for later analysis of infant attention to the video (peer, adult, and baseline videos).

Test Session: At each age, half the infants were tested immediately after watching the video, and half the infants were tested after a 10-minute delay (resulting in n = 12 infants per experimental group at each age). In all groups, the experimenter said "Let's find some toys for you to play with" and removed two large black room dividers (92cm wide, 127cm high, and 117cm wide, 127cm high) that had occluded a corner of the experimental room behind the child during the video demonstration.

Removing the dividers revealed a child-sized chair and a table on which the rattle stimuli had already been placed. Thus, the adult experimenter did not have any physical interaction with the stimuli at the start of the test session. Caregivers were requested not to provide any verbal or physical prompts to their child during the test session. Each infant had 60s to produce the target actions from the time he or she first touched the stimuli. Infants were video-recorded during test for later analysis.

The *Television Viewing* and *Peer Contact* questionnaires were sent to the caregivers. Of 120 questionnaire sets given to caregivers, 80 (66.6%) Television Viewing and 81 Peer Contact (67.5%) were returned. Preliminary analyses revealed that mothers who returned the questionnaires did not differ in their educational level from mothers who did not return the questionnaires. Furthermore, there were no differences in imitation scores between infants whose mothers did and did not return the questionnaires.

Results

Visual attention. To determine whether attention to the videos differed as a function of whether an adult or a peer was demonstrating the actions, the amount of time infants spent looking at the screen was examined. To do this, infant looking was coded off-line using an activity timer, a computer program specifically designed for coding accumulative looking. A computer key was pressed down for the duration over which the infant attended to the screen. The program automatically summed up the episodes of looking in milliseconds, and allowed a percentage of time attending to the screen during the video to be calculated for each infant. Video records for three infants were missing due to the infant moving out of camera range (one 15-month-old boy in the *Peer Video Immediate* group, one 15-month-old girl in the *Baseline* group), and experimenter error (one 24-month-old boy in the *Peer Video Immediate* group).

Preliminary analyses revealed that there were no gender differences in visual attention to the screen at either age, biggest $t(57) = 1.19$, $p = .24$. Therefore, data were collapsed across gender for all subsequent analyses on visual attention.

15-month-old infants' attention in the two baseline groups did not differ depending on whether they saw an adult or a peer model ($M = 71.86\%$ for the adult video; $M = 77.07\%$ for the peer video), $t(9) = 0.43$, $p = .67$. In the same way, 24-month-old infants' attention in the baseline group did not vary as a function of model ($M = 88.55\%$ for the adult video; $M = 88.67\%$ for the peer video), $t(10) = 0.02$, $p = .98$. Therefore, visual attention to the two baseline videos was collapsed for all subsequent analyses. Overall, attention to the screen was high in all groups (see Table 1). Separate one-way ANOVAs across groups for each age revealed that visual attention did not vary as a function of group at either of the two ages, biggest $F(4, 53) < 1$. However, a t-test for independent samples revealed an age-related increase in visual attention, $t\ (115) = 6.21$, $p < .01$.

Taken together, infants at each age attended all videos for a similar amount of time. The only systematic change in visual attention was an overall age-related increase to all of the videos.

Insert Table 1 about here

Latency to imitate: It is possible that watching either an adult or a peer interacting with stimuli might create a higher level of motivation in infants to subsequently interact with those stimuli, which in turn might affect the rate at which target actions are produced. To assess this possibility, we coded the latency before infants started interacting with the stimuli once they were within reach during the test session. Separate ANOVAs across groups for each age group revealed that there were no significant differences in the latency to touch the stimuli at either age (biggest $F(4, 55) = 2.42$, $p = .06$). Furthermore, a t-test for independent samples revealed that the latency to touch the stimuli did not vary as a function of age, $t(117) = 0.23$, $p = .82$. Thus, on average infants at both ages started to interact with the stimuli after a similar amount of time (15-month-old infants: $M = 2.15$ seconds; 24-month-old infants: $M = 2.37$ seconds).

Imitation scores: Infant imitation during the test session was coded from videotape. Infants were awarded a single point for each target action produced (maximum = 3). The three target actions consisted of (1) pushing the ball through the diaphragm into the jar, (2) putting the stick on the jar, attaching with the Velcro, and (3) shaking the stick to make a noise. One observer scored the presence or absence of each target action during test from video tape. A second independent observer scored 40% of the videos. Inter-rater reliability calculated using the Kappa-statistic yielded a coefficient of $\kappa = 1$.

Preliminary analyses revealed that there were no gender differences in imitation scores at either of the two ages, biggest $t(58) = 0.54$, $p = .59$. Therefore, for all subsequent analyses imitation scores were collapsed across gender.

To assess whether there were differences in imitation scores, data were subjected to a 2 (Age) x 5 (Group) ANOVA. There was a significant main effect of Age, $F(1, 110) = 9.10$, $p < .01$, indicating that, overall, imitation scores increased as infants got older. There was also a main effect of Group, $F(4, 110) = 5.63$, $p < .01$, indicating that, overall, infants in the demonstration groups produced significantly more target actions than infants in the baseline groups. Furthermore, there was a significant Age x Group interaction, $F(4, 110) = 2.90$, $p = .03$ (see Figure 1).

Insert Figure 1 about here

To assess the Age x Group interaction, data were subjected to separate one-way ANOVAs across groups for each age. In imitation experiments, performance of the experimental groups is compared to performance of the baseline control groups to infer learning/memory. Thus, post-hoc Dunnett's t-tests were conducted for each age. At 15 months of age, the overall ANOVA did not reach a level of statistic significance, $F(4, 55) = 2.05$, $p = .10$. However, the post-hoc Dunnett's t-test revealed that one experimental group performed significantly above baseline that is, the *Adult Video Immediate* group, $p = .03$. At 24 months of age, there was a significant effect of group, $F(4, 55) = 5.39$, $p < .01$. The post-hoc Dunnett's t-test revealed that three of the four experimental groups performed significantly above baseline that is, the *Peer Video Immediate*, *Peer Video Delay*, and *Adult Video Immediate* groups (biggest $p = .02$).

Next, we examined whether there were any differences in performance between the experimental groups (peer/adult video) at the two test times (immediately/delay) at either age. A series of t-tests for independent samples revealed that when tested immediately, 15-month-old infants' performance was higher after watching the adult video than after watching the peer video, $t(22) = 2.13$, $p = .045$. In contrast, at this age there was no difference in performance as a function of experimental group when the test occurred after a delay, $t(22) = 0$, $p = 1$. At 24 months of age, infants' performance in the two experimental groups did not differ at the immediate test, $t(22) = .19$, $p = .86$. However, when tested after a delay, infants' performance was higher after watching the peer video than after watching the adult video, $t(22) = 2.35$, $p = .03$.

Lastly, we tested whether performance of the experimental groups differed as a function of delay. To do this we compared the performance of the *Peer Video Immediate* group with that of the *Peer Video Delay* group and that of the *Adult Video Immediate* with that of the *Adult Video Delay* group at each age. At 15 months of age, there were no significant differences in performance as a function of delay, biggest $t(22) = 1.64$, $p = .12$. At 24 months of age, performance of infants in the *Adult Video Immediate* group was significantly higher than that of infants in the *Adult Video Delay* group, $t(22) = 2.56$, $p = .02$. There were no differences in performance between the *Peer Video Immediate* and the *Peer Video Delay* group, $t(22) = 0.84$, $p = .41$. Thus, infants at this age showed forgetting of the adult's, but not the peer's, actions over the delay.

Relation between visual attention and imitation. To determine whether there was a relationship between visual attention to the demonstration videos and imitation scores in the experimental groups at either age group, the two measures were correlated for each of the experimental groups separately using the Pearson correlation coefficient. There was no significant relation between visual attention and imitation scores at either of the two ages, smallest $p = .1$. Furthermore, there was no significant correlation between visual attention and imitation scores when data from all four experimental groups were collapsed at each age, smallest $p = .11$. To determine whether there was an overall relationship between visual attention and imitation, data from all experimental groups at both ages were considered. There was a significant correlation between infants' attention to the demonstration video and their imitation scores ($n = 94$), $r = .3$, $p < .01$. Thus, across experimental groups and ages, those infants who watched the video for longer exhibited higher imitation scores than infants who exhibited less attention to the video.

Questionnaire data

To examine whether there were age-related changes in infants' experience with television or with peers outside of the experimental setting, the content of the parental report questionnaires was analyzed.

Television questionnaire: Analyses of the parental questionnaires revealed four important age-related changes in infants' television viewing (see Table 2). First, a Chi-Square test indicated 24-month-old infants were reported as being significantly more likely than 15-month-old infants to watch television at all (97.56% vs 84.6%), χ^2 (1, $N = 80$) = 4.2, $p = .04$ (*Fisher's exact test* $p = .05$). Second, in accordance with earlier reports (McCall et al., 1977), there was an age-related increase in the amount of time spent watching television per week, $t(70) = 2.26$, $p = .03$. Third, when watching television, 24-month-old infants were reported to attend to the television for a significantly larger proportion of time than the 15-month-old infants, t (71) = 3.86, $p < .01$. Fourth, 15-month-old infants were reported as spending significantly more time watching television with their caregiver than the 24-month-old infants, $t(71) = 2.63$, $p = .01$.

Insert Table 2 about here

Peer contact questionnaire: Analyses of the peer questionnaires using Chi-square tests revealed that both age groups were equally likely to attend either a nursery or a playgroup, biggest χ^2 (1, $N = 81$) = 0.6, $p = .44$. A series of t-tests also revealed that, amongst those infants who did attend a nursery, there was no age-related difference in the number of days they attended per week or in the number of hours they attended per day (all p's > .05). In terms of playgroup attendance, 24-month-old infants attended playgroups on more days per week (24-month-olds: $M = 1.86$; 15-month-olds: $M = 1.21$), $t(40) = 2.65$, $p = .01$. However, there was no age-related difference in the number of hours attended each day, t(39) = 0.38, $p = .71$. Not surprisingly, there was a significant difference in the amount of time infants had been attending nursery or playgroup: 24-month-old infants had been attending nursery for longer than the 15-month-old-infants (12.33 months compared to 6.13 months, $t(32) = 4.65$, $p < .01$). Similar results were observed for attendance at playgroups: 16.29 months for 24-month-old infants compared to 9.47 months for 15-monthold infants $t(38) = 3.83$, $p < .01$. Finally, to explore the possibility that infants' exposure to peers, in the form of siblings at home, differed between the two age groups, a Chi-square test was conducted. There was no difference in the likelihood of having at least one older sibling between the two groups, χ^2 (1, $N = 81$) = 0.3, $p = .59$. Thus, regular exposure to peers (via siblings) at home was not different for the 15- and 24-month-old infants.

Correlations between imitation scores and television viewing and peer experience.

Finally, we examined whether there was a relationship between infants' experience outside of the experimental setting (with television, and with peers) and their performance in the imitation task. To examine whether there was a relationship between television viewing experience and the ability to learn from television, a correlational analysis was performed between the amount of TV viewing at home, as reported on the questionnaires, and imitation scores of infants in the experimental groups in the current study. In accordance with earlier reports (McCall et al., 1977), there was no significant correlation between these measures (n = 59), r = .15 p = .26.

To test whether the length of regular peer contact was related to infants' imitation from peers or adults, the amount of playgroup and/or nursery attendance in months prior to participation in the present study was correlated with the infants' imitation scores in the peer and adult demonstration video groups. If infants attended both nursery and playgroup, then the institution they started attending first was used as indicator of length of peer exposure. Thirty infants (n = 18 15-month-old and n = 12 24-month-old infants) who were in an experimental group with the peer model (immediate, delay), and also attended nursery and/or playgroup, could be included in the peer analysis. There was a significant positive correlation between the length of regular peer contact (via nursery/playgroup attendance) and infants' imitation scores from peers r = .47, p < .01. Thus, as the duration of nursery attendance increased so did the amount of imitation from a peer model. In contrast, there was no significant correlation between length of nursery attendance and imitation scores from an adult video, r = - .12, p = .59 for the 23 infants who were in an experimental group with the adult model (immediate, delay) and attended nursery/playgroup (n = 6 15-month-old infants and n = 17 24- month-old infants). Thus, attendance at nursery was not associated with an overall increase in imitation levels.

Discussion

The present study reveals that the ability to learn from a peer demonstrator changes as a function of age during the second year of life. Fifteen-month-old infants showed learning from the video of an adult but failed to learn the same actions presented by a peer. In contrast, 24-month-old infants learned equally well from both demonstrators. When tested after a brief delay, 15-month-old infants did not show retention after either model's demonstrations while 24-month-old infants showed significant recall from the peer, but not the adult, demonstration. The 24-month-old infants showed forgetting of the adult model's actions but not of the peer model's actions. Importantly, the differences in learning and memory were not attributable to differences in motivational states (as indicated by the latency to touch the stimuli) or visual attention to either of the videos. These age-related changes in infants' responsiveness to a peer demonstration are consistent in timing with changes observed in non-verbal imitation occurring in social interactions between peers (Eckerman et al., 1989). In contrast to observational studies on early peer relations that mainly focused on immediate imitation (e.g., Eckerman et al., 1975, 1989), our results show that encounters with peers can alter 24-month-old infants' behavior even after a delay, and in the absence of the peer model. Taken together, social and cognitive studies confirm that peers play an increasingly important role on infant behavior during the second year of life.

In contrast to the report of Ryalls et al. (2000) with infants aged between 14 and 18 months, a peer-model advantage was not found in our youngest age group. In the present study, infants were presented with videoed rather than live demonstrations, which may provide a possible explanation for the apparent discrepancy in age effects observed across the two studies. In general, when all aspects of the learning situation remain constant, infants will be older when they show successful learning from a video compared to a live demonstration (e.g., Barr & Hayne, 1999). Televised interactions lack qualities that are typical in real-life social exchanges, including turn-taking and pointing, and as such generally result in lower levels of infant learning (Troseth, Saylor, & Archer, 2006). Given the reduction in social cues provided by a televised learning situation, it is perhaps even more impressive that infants in the present study still appeared to draw upon information provided by the identity of the televised model. Apart from the well documented fact that learning from television is more difficult than learning from live models, performance on both tasks does appear to be influenced by similar parameters, such as infants' age, retention interval and number of study trials (e.g., Barr & Hayne, 1999; Barr, Dowden, & Hayne, 1996; Barr et al., 2007b). Thus, although an extension of the present research under more naturalistic conditions of live modeling would determine the generality of our findings beyond the medium of televised models, we believe that a learning medium explanation alone seems unlikely to account for the observed age differences.

Whilst some researchers have argued that actions from peers might be more easily copied than those of adults (Eckerman et al., 1995), others have suggested that infants' actions are generally more ambiguous than those of older children and adults (Vandell & Mueller, 1980). From the latter point of view, ambiguity in the peer model's actions might be seen as the reason for the 15-month-old infants to fail imitating the peer model, but not the adult model. When producing the demonstration videos, we sought to obtain a close match between the two models' actions by having the adult model watch the peer model's demonstrations and simultaneously imitate the actions. Therefore, the speed of the actions and the way they were carried out were very similar in both videos. Any ambiguities that caused difficulties in imitating the peer model's actions should have also been apparent in the adult model's demonstrations. Inherent differences between the two models such as size of their hands could of course not be eliminated. Nevertheless, the match of the peer and adult's actions in the present study was potentially closer than might be experienced in daily life situations.

The age-related change in learning from adults versus peers observed in the present study may be explained, at least in part, by the social context that infants have experienced outside of the experimental situation. Our questionnaire data suggest that a combination of different environmental factors may influence infants' learning from peers and adults. First, 15-month-old infants spent more time watching television with their caregiver than the 24-month-old infants. Mothers have previously been shown to scaffold their infants' television viewing through questions, labels and descriptions during viewing (Barr, Zack, Garcia, & Muentener, 2008). Thus, for younger infants, watching television appears to be a largely adult-led experience. This might have contributed to the effectiveness of the adult model in our study with the 15-month-old infants, as younger infants may be accustomed to adults teaching them within a television viewing context.

A second potential explanation for the age-related changes in the effectiveness of adult versus peer models stems from the different amount of peer exposure that tend to occur as a function of age.. In the present study, the length of regular peer contact through nursery and/or playgroup attendance was associated with imitation scores from peers. That is, the more regular peer contact infants had experienced outside of the experimental setting, the higher their imitation scores after watching a video with a peer model. In contrast, length of nursery/playgroup attendance was not associated with imitation scores from adults. This suggests that prolonged regular contact to peers does not enhance imitation in general, but specifically enhances imitation from peers. Previous research (Becker, 1977) has demonstrated that experience with peers alters the way infants interact with, and react to, other infants. Overall, 24-month-old infants in our study had had longer regular peer exposure than 15-month-old infants. We believe that increased exposure may lead infants to appreciate that peers can be important and reliable models. Prior research has shown that infants are most likely to imitate actions from models who carry out intended rather than accidental or unfinished acts (e.g., Carpenter, Akhtar, & Tomasello, 1998, Legerstee & Markova, 2008; Meltzoff, 1995), and it is possible that a less experienced infant will fail to judge a peer's behaviors as purposeful. From this point of view, the younger infants' failure to learn from a peer model does not reflect a cognitive problem but rather a lack of social experiences. However, these younger infants might be perfectly adapted for their developmental niche within which they mainly encounter adult teachers (cf. Rovee-Collier & Cuevas, 2009; Rovee-Collier, 1996). Infants who had spent more time with peers, in contrast, might have adjusted to having a wider range of potential teachers available and learnt to capitalize on their peers' knowledge. These infants are also perfectly adapted to their developmental situation.

It is important to note that the present study does not determine the nature of the knowledge that infants acquired from peers compared to adults. There is considerable debate in the human and animal literature surrounding whether a specific copying behavior can be defined as true imitation (for review, see Whiten, McGuigan, Marshall-Pescini & Hopper, 2009). Alternative explanations for a contingency between the actions of the demonstrator and the observer have included stimulus enhancement, where the actions of the demonstrator serve to increase interest in, and spontaneous exploration of, the object, and emulation, where the observer learns how to reach the end goal without copying the exact means in which the goal was reached. This distinction is held to be crucial because different forms of observational learning rely on different socio-cognitive mechanisms. With human infants, the use of appropriate control and baseline groups in most research using action-with-object imitation, as in the present study, rules out the possibility of local/stimulus enhancement (see Meltzoff, 1985). The possibility of emulation rather than imitation remains more controversial. However, other deferred imitation studies have suggested that from the end of the first year onwards, infants start to understand what other people might be trying to achieve with their actions (Legerstee & Markova, 2008; Meltzoff, 1995), thus demonstrating imitation rather than emulation. A future avenue for research would be to consider whether infants are more successful at inferring the goal of an event from the actions demonstrated by a peer or by an adult.

The present results highlight the importance of considering infants' experiences outside the experimental situation when studying learning and memory. Doing this might help us understand *why* certain age-related changes occur rather than merely documenting their existence (cf. Rovee-Collier, 1996). The fact that prolonged exposure to peers was exclusively related to imitation from peers and not adults illustrates that the relations between cognitive development and other domains of infant development can be very specific. Another example of such specific relation is the association between the onset of locomotion and flexibility of memory retrieval as documented by Herbert, Gross, and Hayne (2007). In that study all infants showed retention in an imitation task when tested with the same stimulus in the same context, but only infants who had started crawling showed retention when tested with a different stimulus in a different context. Thus, flexibility of memory retrieval, but not memory in general, was enhanced by independent locomotion. Herbert et al. suggested that the crawling infants might have had more opportunities to retrieve their memories in different contexts and different situations than non-locomoting infants. In this way, the locomoting infants benefited from the additional experiences that independent locomotion provided them with rather than through locomotion *per se* having a direct influence on flexibility of memory retrieval. Similarly, we suggest that prolonged peer exposure provides infants with the chance to become aware of the value and importance of peer models.

The present findings can also be considered within the frameworks of two theoretical perspectives on development: social learning theory (Bandura, 1977), and social systems theories (e.g., Lewis, 2005). Social learning theory states that, generally, not all models will be imitated equally. For example, models who possess “engaging qualities” (Bandura, 1977, p. 24), who have had similar experiences as the observer, and who are high in status and competence are assumed to be particularly effective in eliciting imitative behavior. Furthermore, children are thought to imitate more behaviors from their mother than from unfamiliar adults (Bandura, 1977). In this framework, peer relations are thought to be mainly influenced by parental models, and peer interactions to be limited by infants’ capacities for learning (Hay et al., 2009). From this perspective, infants might be expected to acquire knowledge from peer models later than they do from adult models. An alternative view about learning from adults and peers could be predicted by social system theories in which infants are proposed to develop multiple social relationships independently from each other (e.g., relationships to caregivers and peers) because they are interested in their conspecifics in general. From this point of view, relationships with different social partners might follow a similar timetable (cf. Hay et al., 2009). Thus, the social systems theory might predict that infants at all ages should show similar capacities for learning from peers and adults. The results of the current study provide greater support for social learning theory. However, it should be noted that the relationships that can be drawn between the present data and classical developmental theories remain indirect. While the present findings indicate that infants' social interactions have lasting impact on their behavior within the infancy period, "no major developmental theory has explicitly predicted that young peers will interact in meaningful ways" (Hay et al., 2009, p. 122). In fact, empirical evidence for the existence of social competence with peers during infancy "provides a major challenge to received wisdom" (Hay et al., 2009, p. 123).

Finally, Meltzoff (2007) has proposed that the degree of 'like-me-ness' may have an effect on infant performance in social-cognitive tasks, such as when the infant eavesdrops on another person being scolded for performing an action with an object prior to the infant being given the opportunity to play with that object (e.g., Repacholi & Meltzoff, 2007; Repacholi, Meltzoff, & Olsen, 2008). Meltzoff (2007) has suggested that if the model being scolded was more similar to the infant (i.e., another infant), then the observing infant might learn more from their 'eavesdropping' experience, showing increased reluctance to copy the demonstrated actions compared to when the model was less similar to the infant (i.e., an adult). To our knowledge, these studies of infants' learning from other infants have yet to be conducted, but on the basis of the present findings we would suggest that similarity between the demonstrator and the observing infant may become more important as infants get older. Early in the second year of life, infants seem to still be developing their awareness of the similarities between themselves and other children and only just beginning to appreciate the relevance of another child's actions for teaching them new behaviors.

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Table 1.

Percentage of total time (+/- 1 S.E.) that 15- and 24-month-old infants' attended to the demonstration video in each group.

	15-month-old infants	**24-month-old infants**
Baseline	74.7% (5.74%)	88.61% (2.39%)
Peer video immediate	78.77% (4.82%)	88.56% (4.1%)
Peer video delay	72.01% (4.24%)	86.39% (4.35%)
Adult video immediate	69.64% (3.75%)	91.76% (1.93%)
Adult video delay	70.68% (3.88%)	86.72% (3.66%)

Table 2.

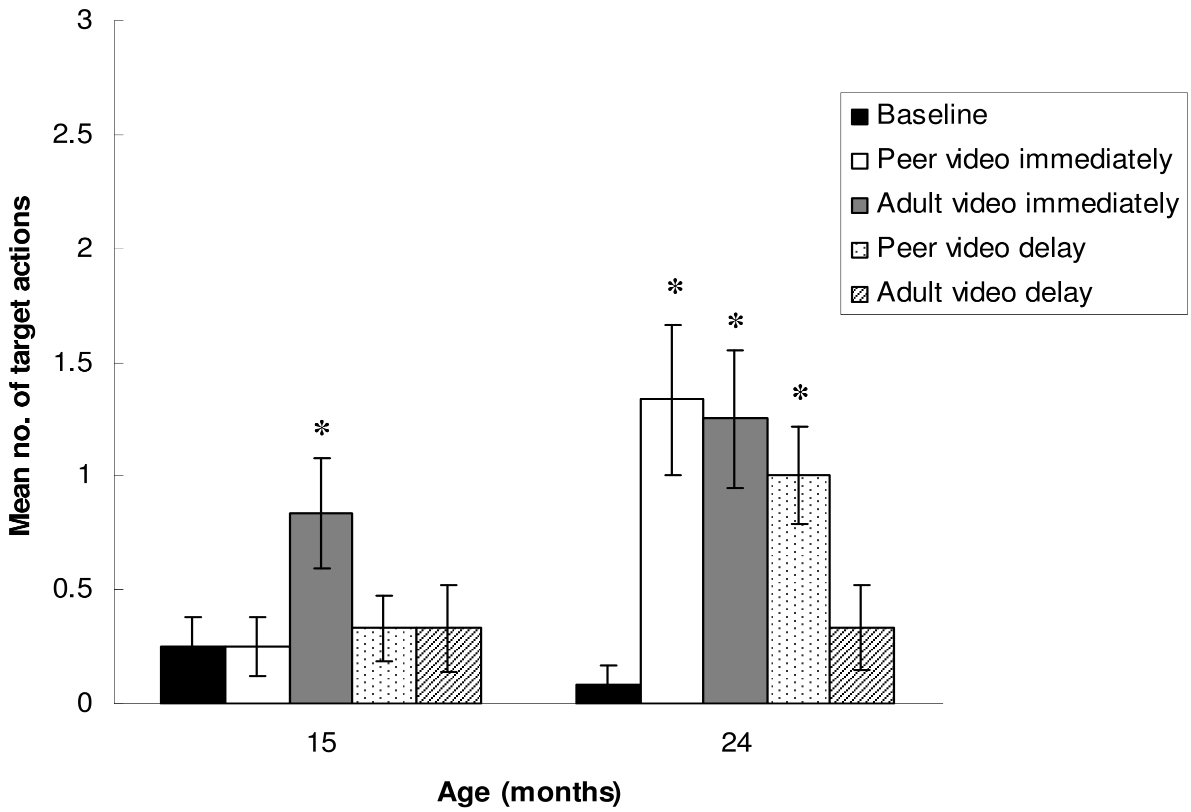
Age-related changes in television/video viewing according to parental report (included are only those infants who were reported to watch television/DVDs at all.

Questionnaire item	**15-month-olds** (*n*=33)	**24-month-olds** (*n* = 40)
Q1 Amount of viewing (hours per week)		
Less than 1 hr	15.2%	5.1%
1 – 3 hr	30.3%	17.9%
4 – 6 hr	18.2%	23.1%
7 – 9 hr	21.2%	20.5%
10 – 12 hr	6.1%	12.8%
13 – 15 hr	9.1%	19.9%
16 – 18 hr	-	-
Over 18 hr	-	2.6%
Q2 How often is the infant attending to the screen when watching TV?		
Never	-	-
Occasionally	42.4%	15%
Half the time	45.5%	37.5%
Most of the time	12.1%	40%
All of the time	-	7.5%
Q3 How often is the caregiver co-viewing TV with the infant?		
Never	-	-
Occasionally	15.2%	12.5%
Half the time	15.2%	52.5%
Most of the time	42.4%	30%
All of the time	27.3%	5%

Figure captions

Figure 1. The mean imitation scores (+ 1 *SE*) of infants as a function of age and experimental group. An asterisk indicates that a group's performance is significantly higher than that of an age-matched baseline control group.

Figure 1.


3
2.5
2
1.5
1
0.5
0
Mean no. of target actions
15
24
Age (months)
*
*
*
*
Baseline
Peer video immediately
Adult video immediately
Peer video delay
Adult video delay