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Revisiting the Effect of Reminders on Infants' Media Memories: Does the Encoding Format Matter?

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With the present research, the authors examined whether reminders could maintain 18-month-olds' memories generated from picture books and videos. Infants ($N = 98$) were shown a series of target actions in a picture book or on video. Either 24 hr or 2 weeks prior to a 4-week deferred imitation test, they were exposed to a reminder, a partial presentation of the original media demonstration. After both reminder delays, groups that received a video demonstration and a video reminder (*video/video*) performed significantly better than did the video-reminder-only control group (*x/video*), but groups that received a picture-book demonstration and a picture-book reminder (*book/book*) did not perform better than did the picture-book-reminder-only control (*x/book*). Additionally, if reminders did not veridically match the conditions of encoding (e.g., video demonstration and a book reminder, *video/book* or vice versa), infants also failed to perform better than controls. Theoretical implications for the understanding of long-term memory processing during early childhood and practical implications for early multimedia usage are discussed.

Keywords: imitation, infants, media, memory, reminders

Given the rapid increase in infant exposure to media in recent decades, it is important to understand what infants can learn from television and books and whether there are any differences in learning between the media types. Large-scale parental surveys estimate that 70% of infants in the United States watch around 1 hr of television and video daily and that 80% are read to for around 30 min each day (Rideout & Hamel, 2006). Clearly, from infancy onward, both television and books feature heavily in everyday life. Studies using the deferred imitation paradigm have shown that young children can learn from these media by copying novel action sequences from television (Barr & Hayne, 1999; Barr, Muentener, & Garcia, 2007; Barr, Muentener, Garcia, Fujimoto, & Chavez, 2007; Barr, Shuck, Salerno, Atkinson, & Linebarger, 2010; Barr & Wyss, 2008; Hayne, Herbert, & Simcock, 2003; Meltzoff, 1988; Strouse & Troseth, 2008) and picture books (Simcock & DeLoache, 2006, 2008; Simcock & Dooley, 2007). However, infants consistently learn more from direct observation of a live demonstration than from a symbol-based media demonstration of an event (see Barr, 2010, for a review).

For information encoded via any format to contribute to an adaptive knowledge base, it must be accessible in a variety of situations. For example, the information must be retrieved even when the recall situation differs from the learning situation (generalization) and the information must be accessible over the long term (retention). Prior research shows that memories encoded from media-based formats are generalizable to novel situations (Barr & Wyss, 2008; Simcock & Dooley, 2007) and can be retained over the long term (Brito, Barr, McIntyre, & Simcock, 2012). Finally, even when some forgetting occurs over long delays, the memory should still be maintained across development if cues are periodically encountered (reinstatement or reactivation). A well-established principle of memory development is that younger infants forget at a much faster rate than at any other time in the lifespan (Barr & Hayne, 2000; Rovee-Collier & Hayne, 1987; Spear & Parsons, 1976). Depending on the paradigm used, forgetting is defined as the experimental group not differing in levels of performance from that of baseline or no-experience controls. Despite the fact that significant forgetting is observed over long retention intervals, memories that appear to be forgotten can be retrieved and expressed over very long delays if infants are given a reminder treatment (e.g., Rovee-Collier, Sullivan, Enright, Lucas, & Fagen, 1980; Hayne, Barr, & Herbert, 2003). The reminder treatment must provide the infant with the appropriate cues that match the attributes of the encoding conditions. In the present experiments, we asked whether reminders can maintain memories originally generated from picture books and videos over a long delay and whether the nature of the encoding format affects the success of reminder treatments.

We used two reminder procedures, reactivation (Rovee-Collier, 1997; Rovee-Collier, Hayne, & Colombo, 2001; Spear, 1973;

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Spear & Parsons, 1976) and reinstatement (Campbell & Jaynes, 1966), to address this question. *Reminder* is defined as a fractional component of the original event that when presented alone does not result in new learning. *Reactivation reminders* have a facilitative effect on retention of a preexisting memory representation, accessing a memory after it has been forgotten (Cave, 1997; McNamara, 1992; Musen & Treisman, 1990; Ratcliff & McKoon, 1988; Rovee-Collier, 1997; Schacter, 1990; Tulving & Schacter, 1990). *Reinstatement reminders* refresh a memory that is nearly forgotten and maintain it at that level, analogous to a memory booster or inoculation (Hildreth, Sweeney, & Rovee-Collier, 2003). Two components of a reminder's effectiveness are directly measurable: (a) the effect of the *timing* of the reminder, and (b) the *expression* of the prior memory during a subsequent retention test. Interpolated between these empirical components is a third component that is not available to empirical scrutiny: a *hypothetical memory retrieval process* (i.e., increasing the speed of processing and accessibility of attributes in the original memory).

In the first study of infant memory reactivation, Rovee-Collier et al. (1980) showed that 3-month-olds, who forgot an operant mobile within a week, exhibited near-perfect retention a month after operant training if they were exposed to a reactivation reminder 24 hr prior to the memory test. Two additional control groups failed to exhibit retention on the long-term test: (a) a *forgetting control group* that received training but no reactivation reminder and (b) an *untrained reminder control* group that received only a reminder. These groups ensured that the original memory had been forgotten and that the reminder produced no new learning.

Researchers using imitation tasks have also found that exposing infants to a reminder after they have forgotten reactivates the memory and renews retention (Barr, Vieira, & Rovee-Collier, 2002; Deocampo & Hudson, 2003; Hayne, Barr, & Herbert, 2003; Hudson & Sheffield, 1998, 1999; Sheffield & Hudson, 1994, 2006). Hudson and colleagues used an imitation paradigm in which 18- to 30-month-olds were shown six or eight multistep activities (e.g., opening a cabinet, removing fish food, and feeding the fish) in a laboratory playroom. They tested infants' ability to imitate these actions 10 or 12 weeks later. Infants who were reminded either via a live reenactment of some of the activities (Hudson & Sheffield, 1998; Sheffield & Hudson, 1994) or an abbreviated video demonstration of all of the activities (Hudson & Sheffield, 1999; Sheffield & Hudson, 2006) before the long-term test had significantly higher imitation scores than did forgetting controls who were not reminded before the test and the untrained reminder controls who were reminded and tested without previously performing the activities. A photograph of one of the original activities was an effective reminder for 24- and 30-month-olds but not 18-month-olds (Deocampo & Hudson, 2003; Sheffield & Hudson, 2006).

The Sheffield and Hudson (2006) study had a number of potential confounds. First, the original demonstrations were performed by a live model (3-D), whereas the reminders were presented via 2-D video and photographs, a mismatch in the conditions at encoding and retrieval that has been shown to hinder recall (see Rovee-Collier & Hayne, 1987). The photograph reminder may not have been effective for 18-month-olds, as it included only one image of the target objects rather than sequential information or dynamic motion cues that were included in the video reminder, and it is possible that this specific snapshot was not represented in the original memory. The authors hypothesized that the photograph reminder might have been more effective had additional photographs of target actions been included (see also Deocampo & Hudson, 2003).

The more surprising finding was that the video reminder served as an effective cue for the actions learned via a live interaction. This suggests that infants perceived the attributes of the 2-D reminder as equivalent to the 3-D encoding conditions. Alternatively, either a return to the unique laboratory context in which learning occurred for the reminder session or additional information added to the video reminder from the learning event may have cued the original memory. In the video reminder, an unknown child performed the target actions accompanied by full experimenter narration and explicit verbal prompts (e.g., "Look, here is my fish. Do you remember what we do with the fish? Yes, that's right; there is fish food in the drawer. Shake fish food over the tank"). Finally, differences between the groups were also difficult to interpret because the delay between original encoding and the test was confounded with the delay between the reminder and the test.

The current experiments were designed to examine the effectiveness of reminders in restoring and maintaining 18-month-olds' memories of target actions they had seen demonstrated in books or on video 1 month earlier. Like Deocampo and Hudson (2003), we used deferred imitation to eliminate self-produced actions as a basis for remembering (cf. Barr & Hayne, 2000; Meltzoff, 1990), but we eliminated confounds by using one activity rather than multiple activities, closely matching the content of the reminders with sequential information in both picture-book and video reminders, and tightly controlling the encoding conditions. Previously, we had established the parameters necessary for 18-month-olds to imitate a three-step rattle sequence they had been shown in a picture book or on a video (Simcock, Garrity, & Barr, 2011) and then subsequently established that both encoding format groups exhibited significant retention of the target actions after 2 weeks but not after 4 weeks (Brito et al., 2012). That is, after 2 weeks, infants who had been shown the target actions in a book or on video exhibited retention, as their performance was significantly better than that of baseline control groups and did not differ from one another. After 4 weeks, they exhibited forgetting, as their performance did not differ from that of the control group; operationally, by 4 weeks, they had forgotten the task.

Experiment 1: Reactivation

Infants were reminded with a brief exposure to the target actions in a picture book or on video 24 hr prior to the 4-week retention test. If the results were parallel to those of Sheffield and Hudson (2006), then the video reminder would alleviate forgetting but the picture-book reminder would not. These data, however, would raise a second important question: Would the video reminder be effective regardless of the encoding format? To this end, we attempted to use a video reminder to reactivate the memory of the sequence of target actions that the infant had seen in picture books 1 month earlier. We thought it prudent to also use the picture book to reactivate the memory of the sequence of target actions that the infant had seen on video 1 month earlier. Should the video reminder reactivate the picture-book memory, then we could conclude that infants perceived the sequence of target actions in the

video reminder and picture book as functionally equivalent. Should the picture-book reminder reactivate the video memory, then this would confirm that they were perceived as functionally equivalent irrespective of the encoding format. If not, then it is the relation between the encoding format and the reminder that is key for the reactivation effect.

Method

Participants

The final sample included 72 (36 girls) typically developing 18-month-olds ($M = 18.56$ months, $SD = 0.32$), recruited from primarily Caucasian ($n = 50$) middle- to high-income families (M parent education = 17.7 years, $SD = 0.7$); the data were collected from the same subject population as in Brito et al. (2012). Infants were randomly assigned to four independent encoding format/reminder groups (*video/video, book/book, video/book,* or *book/video*) or two independent untrained reminder control groups (*x/book* or *x/video;* the *x* indicates that the control groups did not participate in the demonstration phase of the experiment but received only the reminder and the test phases). Additional infants were excluded because of experimenter error ($n = 1$) and infant refusal to touch the test stimuli ($n = 2$).

Apparatus

Using identical stimuli to that used in Brito et al. (2012), the same three target actions were required to assemble a red or green rattle: (a) push the ball into the jar, (b) attach the stick to the jar, and (c) shake the stick to make a noise. For the demonstration and reminder phases professionally produced videos and picture books equated for color, contrast, clarity, and narration were used and depicted an experimenter demonstrating how to construct a toy rattle (see also Brito et al., 2012; Simcock et al., 2011). The narrative cues in the picture book and video were identical to those used in other imitation studies (e.g., Brito et al., 2012; Hayne & Herbert, 2004; Simcock & DeLoache, 2006; Simcock et al., 2011) and described the goal and target actions required to make the rattle (e.g., "Linda pushes the ball into the jar. Linda picks the stick up and puts it on the jar. Linda shakes the stick to make a noise: shake shake"). The narrative is ecologically valid, as it mimics how infants encounter books and videos in the real world. The experimenter read the picture book to the infant; the same narrative was dubbed directly onto the video as a voice-over. The video was shown on a portable DVD player (Element E1023PD Portable DVD Player) with screen dimensions of 22 cm × 13 cm, and the picture-book dimensions were 18 cm × 14 cm.

We constructed video and picture-book reminders from the original demonstration materials. Both the picture-book and video reminders lasted approximately 10 s and included close-up depictions of all three target actions: place the ball in the jar, place the stick in the jar, and shake the stick to shake the rattle. The book reminder was three static images on successive pages of the picture book and the video reminder was a continuous video clip of the three target actions. For both reminders, the information provided was sequential, took the same amount of time, and included the same narration with the following three phrases, "Look at what Linda is doing! Do you see what Linda is doing with those things? Look at what Linda is doing this time—wow!"

Procedure

Infants were assessed at home during a play period. Caregivers were asked not to comment about the target actions during the visits or the retention interval. Infants in the experimental groups (video/video, book/book, video/book, book/video) participated in three sessions (demonstration, reminder, and test). The demonstration and reminder were separated by a 4-week delay and the reminder and test were separated by a 24-hr delay. The infants in the x/video and x/book control groups participated in two sessions (a reminder and test) separated by 24 hr. These control groups ensured that the infants did not imitate from the 10-s reminder of the book or video alone. All sessions were recorded.

Demonstration. After a free-play warm-up, the infant was seated approximately 30 cm away from the portable DVD player or picture book held by the experimenter. If the infant looked away during the demonstration, the experimenter redirected the infant's attention to the video or picture book by pointing and saying the infant's name or "look." The set of actions was demonstrated twice, which took approximately 60 s (video = 58 s; book $M = 59.18$ s, $SD = 0.68$).

Reminder. The reminder procedure was identical for the two reactivation control groups and the four experimental groups; however, half of the infants received a book reminder and half the infants received a video reminder. The 10 s (video = 10 s; book $M = 9.29$ s, $SD = 1.21$) reminder was given 24 hr before the deferred imitation test to ensure that the infants did not produce more actions during the test simply because they were behaviorally aroused by the reminder (Spear & Parsons, 1976).

Test. The deferred imitation test occurred 24 hr after the reminder, was the third visit for the infants in the experimental groups and the second visit for the control groups, and was identical for all conditions. The infant and the experimenter were seated facing each other on the floor; the caregiver was seated directly behind the infant. The experimenter placed the three parts of the rattle (ball, jar, and stick) within the infant's reach and provided the infant with the test prompt: "You can use these things to make a rattle. Show me how to make a rattle" (Brito et al., 2012; Hayne & Herbert, 2004; Simcock & DeLoache, 2006; Simcock et al., 2011).

Coding and Reliability

Looking time. To determine whether the encoding and reminding formats were differentially salient, which might account for any subsequent differences in imitation score, we timed the duration that each infant looked to the video or picture book on the basis of the direction of the infant's eye gaze during the encoding and reminder sessions. Looking time toward the demonstration was divided by the total length of the demonstration. A second coder independently coded 30% of the data and intercoder reliability using an intraclass correlation of 0.92 was obtained.

Imitation score. The infant's production of the three target actions was coded from a video recording of the test session. Infants were given 1 point for the production of each of the three target actions completed in any order within the 60-s test phase

(score range = 0–3). A second coder independently scored 30% of the video clips and intercoder reliability between the experimenter and the second coder was perfect ($\kappa = 1.0$).

Results and Discussion

Looking Time

There were no significant differences between looking time during the picture-book demonstration ($M = 89.17\%$, $SD = 14.33$) and video demonstration ($M = 90.70\%$, $SD = 19.54$), $F(3, 43) < 1$. A 2 (control, experimental) × 2 (book, video) analysis of variance (ANOVA) showed that there was no significant difference between looking time during the book reminder ($M = 89.33\%$, $SD = 14.46$) and the video reminder ($M = 93.27\%$, $SD = 7.91$), $F(1, 68) = 1.80$, $p = .18$; no significant main effect for experimental group, $F(1, 68) < 1$; and no significant interaction, $F(1, 68) < 1$. For experimental participants, a one-way analysis of covariance (ANCOVA) exploring the association between infants' looking time during the initial demonstration and their imitation scores indicated no significant association, $F(1, 38) < 1$, and also no significant association during the reminder, $F(1, 39) = 1.79$, $p = .19$, $\eta_p^2 = .05$. Therefore, looking time was not considered further.

Imitation Score

We had two primary research questions. First, could a matched video or picture-book reminder remind infants of information encoded from video or a picture book (video/video, book/book)? Second, could a mismatched reminder remind infants of information encoded from a video or a picture book (video/book, book/video)? We operationally defined *reactivation* as the performance of the experimental groups significantly exceeding the performance of the video and picture-book untrained reminder control groups (x/video, x/book).

A one-way ANOVA across the six groups (video/video, book/book, video/book, book/video, x/video, x/book) yielded a significant main effect of experimental group, $F(1, 66) = 2.78$, $p = .03$, $\eta_p^2 = .17$. As shown in Figure 1, post hoc Student Newman–Keuls ($p < .05$) analyses across experimental conditions indicated that only the performance of the same-format video/video group ($M = 1.83$, $SD = 0.72$) significantly exceeded the performance of the media-matched x/video control group ($M = 0.83$, $SD = 0.58$). None of the other experimental groups differed from the media-matched untrained reminder control groups or from one another.

Although these findings indicate that there were group differences, the greater efficacy of the video reminder for the video encoding format was demonstrated in the individual pattern of responses, not just a statistical difference determined by the group. Of the 12 infants in the reminder-only control groups (x/book, x/video), only one infant per group (8.33%) had a score of 2 or more. Two of the 12 infants per group (16.6%) in the book/book and book/video groups and four of the 12 infants (33.33%) in the video/book group had a score of 2 or more. Of the 12 infants in the *video/video* group, however, 10 (83.3%) had a score of 2 or more. Nonparametric Mann–Whitney *U* tests indicated that the video/video group was significantly different from the x/video group ($p = .001$) but no other group comparisons were significant.

The results show that memories encoded from video and reminded with a video reminder (video/video) could reactivate the original memory, but this was not the case for actions encoded from and reminded via books (book/book). The modification of the picture-book reminder from one image (Sheffield & Hudson, 2006) to three images depicting the discrete order information of the three target actions was not effective.

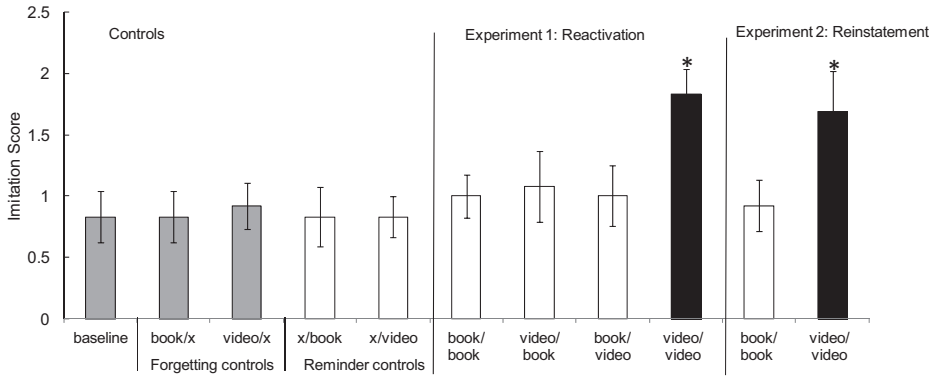

Figure 1. Imitation scores for the control groups, spontaneous baseline control (*baseline,* no demonstration/no reminder), forgetting controls (*book/x, video/x,* demonstration/no reminder) and reminder controls (*x/book* and *x/video*, no demonstration/reminder) are shown in the left panel. Imitation scores for Experiment 1 reactivation groups are shown in the middle panel and for Experiment 2 reinstatement groups are shown in the right panel. Filled bars, *video/video* reactivation, and *video/video* reinstatement represent the only groups that exceeded the performance of reminder control groups, x/book and x/video (open bars, left panel). Note that the baseline and forgetting controls shown in gray are plotted from Brito et al. (2012) for comparison purposes only. Error bars represent standard errors. The asterisks represent group performance that exceeds that of the reminder control groups.

That is, the book reminder was unable to retrieve the forgotten memory. Mismatched reminders also did not facilitate recall (book/video and vice versa). Taken together, these findings confirm that the reactivation effect is specific to the encoding format and there is no evidence to suggest that infants perceived the target actions in the two different formats as functionally equivalent.

Experiment 2: Reinstatement

Returning to our original research question regarding the differential effectiveness of video and picture-book reminders to maintain memories, we used the second reminder procedure, reinstatement (Campbell & Jaynes, 1966), to provide convergent evidence that the reminder was specific to the encoding format. Whereas in the reactivation, the reminder is presented after the memory is forgotten and therefore alleviates the forgetting (Spear & Parsons, 1976), in the reinstatement procedure, the reminder is presented near the end of the retention interval, before the memory is forgotten (Campbell & Jaynes, 1966). Reinstatement arrests forgetting and maintains retention at that level for as long as it was remembered before (Barr, Rovee-Collier, & Campanella, 2005; Hildreth et al., 2003). The reactivation and reinstatement reminders are identical except that the memory is younger at the time of reinstatement reminder. Because both the picture-book and the video groups exhibited significant retention for 2 weeks (Brito et al., 2012), we presented the reinstatement reminder 2 weeks after encoding and tested them 2 weeks later, 4 weeks after they had originally seen the target actions. This design ensures that the age of the memory at the time of testing was the same in Experiments 1 and 2.

Method

Participants

The final sample included 26 (14 girls) typically developing 18-month-olds (M = 18.26 months, SD = 0.54) recruited from primarily Caucasian (n = 16) middle- to high-income families (M parent education = 17.2 years, SD = 1.5), and the data were collected from the same subject population as in Experiment 1 and Brito et al. (2012).

Infants were randomly assigned to one of two independent 2-week reminder conditions: book/book or video/video. Additional infants were excluded because of experimenter error (n = 1), infant refusal to touch the test stimuli (n = 1), and infant inattention to demonstration (n = 2). The untrained reminder control groups control for whether the reminder alone would allow for learning, and therefore cross-experiment comparisons were made with the untrained reminder control groups (x/video and x/book) from Experiment 1.

Apparatus and Procedure

The materials, study design, procedure, and analysis were identical to those described in Experiment 1 except that 2-week intervals intervened between the demonstration and reminder and the reminder and test. A second coder independently scored 50% of the demonstration and reminder sessions (intraclass correlation = 0.91). A second coder independently scored 85% of the imitation tests (κ = 0.83).

Results and Discussion

Looking Time

After controlling for unequal variance, there were no significant differences between looking time during the picture-book demonstration (M = 86.03%, SD = 13.81) and video demonstration (M = 94.93%, SD = 6.24), $t(15.31) = 2.03$, $p = .06$. A one-way ANCOVA exploring the association between infants' looking during initial demonstration and their imitation scores indicated no significant association, $F(1, 21) = 2.29$, $p = .14$, $\eta_p^2 = .09$, and there was also no significant association between looking time during the reminder and imitation scores, $F(1, 20) < 1$. A 2 (control, experimental) $\times$ 2 (book, video) ANOVA showed no significant differences between looking time during the book reminder (M = 88.48%, SD = 14.85) and video reminder (M = 93.45%, SD = 5.95), $F(1, 43) = 2.19$, $p = .15$; no significant main effect for experimental group, $F(1, 43) < 1$; and no significant interaction, $F(1, 43) < 1$. Therefore, looking time was not considered further.

Imitation Score

To assess whether the reminders were effective, we conducted a cross-experiment comparison using the untrained reminder control group (x/video, x/book) scores, operationally defining reinstatement as group performance significantly exceeding the performance of the media-matched control groups. An independent t test between the 2-week video/video and x/video groups was significant after controlling for unequal variance, $t(17.7) = 2.34$, $p = .03$, with the performance in the 2-week video/video group (M = 1.69, SD = 1.18) significantly exceeding the performance of the media-matched x/video group (M = 0.83, SD = 0.58). An independent t test between the 2-week book/book and x/book groups was not significant, $t(1, 23) = 0.28$, $p = .78$ (see Figure 1). The individual pattern of results analysis indicated that three of the 12 (25%) infants in the book/book group and eight of the 12 (66.7%) infants in the video/video group had a score of 2 or more. Nonparametric Mann–Whitney U tests indicated that the video/video group was significantly different from the x/video group ($p = .004$), but no other group comparisons were significant. The results of Experiment 2 replicate and extend those of Experiment 1, showing that memories encoded from video and reminded with a video reminder (video/video) could reinstate the memory or, in other words maintained it, but this was not the case for actions encoded from and reminded with picture books (book/book).

General Discussion

In the present study, we examined the effectiveness of 2-D reminders to maintain infants' memory for actions originally learned from media-based demonstrations over a very long delay. The results show that video reminders effectively reminded memories encoded from video demonstrations (video/video) but picture-book reminders did not remind memories encoded from picture-book demonstrations (book/book). This held true whether

the reminder was given before or after the original memory was forgotten. Reminding also did not facilitate recall across modalities (book/video and vice versa).

If simple generalization had occurred and infants had treated the picture-book and video reminders as functionally equivalent, then the video would have reminded the memory encoded from the picture book and vice versa. The current findings from the book/video and video/book groups suggest, however, that the contents of the memory were specific to conditions of encoding and provide additional evidence that generalized reminders are not effective (see also Hayne & Rovee-Collier, 1995; Hayne, Rovee-Collier, & Borza, 1991; Shimamura, 1986; Tulving & Schacter, 1990). This is despite the fact that the reminders included images of the same stimuli and target actions as the demonstration conditions.

The video reminder could recover sequential information acquired via video demonstration. This finding is remarkable as the video/video group only saw a 60-s demonstration of the target actions and a 10-s reminder, yet they recalled the target action after 1 month. In contrast, the picture-book reminder was not effective. Failure of book/book groups after both delays confirms the finding of Brito et al. (2012) that infants had forgotten after 4 weeks. Once forgotten, memories encoded via book or video could not be reminded using the picture-book reminder.

Although infants learn, remember, and forget information from picture books and video via similar trajectories (Brito et al., 2012), the cues to reactivate and reinstate (maintain) those memories as provided by the picture-book reminder were insufficient. It is not possible or even practical to reactivate everything that has been learned. Once forgotten, the inactive memory may lack memory attributes that can be connected to one another, decreasing the probability of reactivation. Reinstatement was also ineffective. To maintain the memory via reinstatement also requires that attributes are connected, and the lack of mapping between attributes in the reminder with attributes that were still part of the memory representation at the 2-week time point may have contributed to reinstatement failure for the book reminder. In this way, reactivation and reinstatement protocols may serve as a more sensitive probe to differences between encoding conditions than recognition memory paradigms alone. These procedures could be an effective way to titrate out which factors might be critical to the formation and retention of information learned from media during infancy.

Our finding that under highly controlled experimental conditions, only video reminders were effective for the video demonstration group, but that picture-book reminders were not effective for the book demonstration group clarifies the findings of Hudson and Sheffield (Hudson & Sheffield, 1999; Sheffield & Hudson, 2006), who also found that video reminders, but not photograph reminders, significantly increased retrieval by 18-month-olds.

Our explanation for this pattern of results focuses on the cues that are available at the time of the reminder and how they relate to the cues available at the time of encoding—a transfer of learning explanation. For example, the video reminder may have been more effective because it was a continuous depiction of the target actions as opposed to discrete sequential depictions of the target actions in the picture-book reminder. The successive actions that are displayed in picture books are devoid of the motor information that temporally connects or links one action to the next on the video. Motion cues (e.g., the ball falling into the jar) and sound cues (e.g., the ball hitting the bottom of the jar) included in the video reminder that could not be included in the picture-book reminder provided a richer complement of retrieval cues, increasing the probability of a match and the accessibility of the existing memory. The effectiveness of motion as a reminder has also been shown in studies using the mobile conjugate reinforcement procedure with infants (Hayne & Rovee-Collier, 1995; Rovee-Collier, Greco-Vigorito, & Hayne, 1993). This account may be amenable to testing: To examine the memory contents, experimenters could remind infants of just one part of the sequence (e.g., just the goal). In future studies, researchers could examine how information could be better integrated in a book reminder by changing the format of the book reminder from three discrete images into a trifold picture instead. Repeating the reminder at different time points may also be more effective (cf. Simcock & Dooley, 2007).

Given the challenges that infants had with reminders of the same media type, it is not surprising that they failed to imitate with a mismatch between the encoding media and reminder media. Even a video reminder with sounds and motion cues was not sufficient to gain access to information learned from a picture book and vice versa. The lack of reminding across modalities was predicted by the wealth of evidence cited earlier that an effective reminder must veridically match the encoding conditions. The basis for the successful reactivation in the Sheffield and Hudson (2006) study is unclear and we can only speculate why. Perhaps the memory of the experimental procedure or context of encoding was updated by attention to a new stimulus to include new information that was present during reminding? Perhaps infants' memories were mediated by prior knowledge, the specificity of the verbal prompt, or novel motoric action demonstrated during the reminder that updated the original memory trace and facilitated imitation? It is possible that under certain conditions, the picture-book and video reminders could be treated as functionally equivalent if the book and video information were integrated as a concept? This could be empirically tested in future studies by establishing the connection between the two media modalities by associating them prior to or at the time of encoding.

In conclusion, although the content of both media we studied was 2-D, our results indicate that the memory attributes of the series of actions that infants encoded from a picture book are independent of and not equivalent to the memory attributes of the same series of actions that they encoded from a video. Although infants are often shown picture books, videos, and related merchandising featuring the same characters (e.g., Dora the Explorer and Thomas the Tank Engine) and content (Raugust, 1996), infants may not be encoding the same attributes from picture books and video. Parents and educators may assume that infants are learning something and recent findings suggest that they are. The question is, are they learning something that is ostensibly equal from each format? Knowing that infants were able to learn and remember the three target actions in each format for the same length of time (Brito et al., 2012), one might expect that each format has equivalent symbolic information about the real world. This assumption has been challenged in the present study, and additional research is required to understand how age-related changes in memory processing influence learning from media content during infancy.

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