

TODDLERS' IMITATION OF NEW SKILLS FROM VIDEO

By

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CHAPTER I

INTRODUCTION

Imitation is one of the first ways that infants can communicate with and learn about people (Meltzoff & Moore, 2002). At first, this may help them to identify others. By 18 months, infants reenact goals, perspectives, and intentions of adults. As a result, imitation can be a very important tool for pre-verbal children. Children regularly observe adults and other children, then use the information in similar situations. Deferred imitation, which involves a child imitating actions over a delay, requires the infant to encode the demonstration when it is modeled and then recall it later from memory. It is very similar to the way that information is encountered in real life, as children often need to apply things learned in one situation to different, new situations. This makes imitation a very useful educational tool.

However, when infants are exposed to adults on video, research suggests that children under 3 years of age may not learn as well as when given the same information in person. This tendency to learn better from face-to-face teachers has been termed the *video deficit*, and has been seen across many different research paradigms (see Anderson & Pempek, 2005 for a review). Toddlers have difficulty learning new words and speech sounds from television (Kuhl, Tsao, & Liu, 2003; Krcmar, Grela, & Lin, 2004), finding hidden objects (Troseth & DeLoache, 1998; Schmidt & Anderson, 2002; Deocampo & Hudson, 2005), recognizing themselves on video (Suddendorf, Simock, & Neilsen, 2007), and imitating new multi-step skills (McCall, Parke, & Kavanaugh, 1977; Barr & Hayne, 1999; Hayne, Herbert, & Simcock, 2003). This is especially troubling because some parents believe that infants and toddlers benefit from infant-oriented videos and television programming. In fact, a recent report (Garrison & Christakis, 2005) found that three quarters of the top 100 videos for babies and toddlers made educational claims, and another found that 56% of parents with children ages 2-6 say baby videos positively affect development (Rideout, 2007).

At least two major hypotheses have been advanced for why children under three may have particular difficulty learning information from video as well as they learn

information directly from people. The first, the *dual representation* hypothesis, deals with how experience may play a role in children's ability to use video as a source of information about their lives. The second, the *perceptual impoverishment* hypothesis, suggests that the perceptual properties of video may make it difficult for children to encode and retrieve rich memories from the medium. In the next sections, we describe how each of these hypotheses apply to the way in which children use information from video.

The Dual Representation Hypothesis

The dual representation hypothesis focuses on the dual nature of objects used as symbols. A mature understanding of symbols requires one to see the symbol as a thing itself as well as a representation that stands for something else. We get information from the object and then apply this information to the referent. The dual representation hypothesis has been studied in detail using photographs, scale models, and math manipulatives (DeLoache, 1991; 1987; 2000; Uttal, Liu, & DeLoache, 1999; Uttal & Newland, 2007). Research in these domains suggests that children under age 3 may have trouble seeing a symbol both ways. In particular, seeing the object as a thing itself may make it harder for children to take the perspective that it stands for something else. For example, children have trouble using a scale model of a room to help them find hidden toys. DeLoache (1987) had children watch as an adult hid a toy in a scale model of a room. Thirty-month-olds had difficulty when asked to find the toy in the matching larger room. They were, however, able to remember the location of the miniature they had actually seen being hidden, despite being unable to use the information to guide their search in the larger room. DeLoache hypothesized that when children were faced with the scale model, they treated it only as a real object (a toy or dollhouse) and were unable to use it as a symbol. Seeing the model this way blocked their ability to see it as referring to the full room, so they were unable to retrieve the full-sized toy.

Additionally, changing the salience of a symbolic object can have an effect on how children use it as a representation of something else. DeLoache (2000) *decreased* the salience of her scale model by putting it behind a pane of glass, inaccessible to the child. Thirty-month-olds were shown where a toy was hidden in a room using the

inaccessible scale model or one that was out on the floor and accessible. Children who saw the model behind the glass found the toy significantly more often than children who saw the accessible model. In a follow-up study, DeLoache *increased* the salience of her model by allowing the children to play with the model before starting the tasks. In this way, children had more experience with the model as an object. Thirty-six-month-olds who played with the model beforehand found the hidden toy significantly less often than their counterparts who did not have the opportunity to play with the model. For very young children, a model whose function as a toy has been highlighted is more difficult to use as a source of information about its referent, whereas a model whose function as a referring symbol has been highlighted is easier to use. These studies add support to the idea that children age 3 and under have trouble thinking about objects as objects as well as seeing through to their relation to other objects.

When applied to video, the dual representation hypothesis suggests that more experience with video as entertainment may highlight the non-referential aspect of video to children. As a result, they may have an especially difficult time using the video as a representation of something real and specific. That is, having watched videos that have no connection to their current situation, and often little relation to reality at all, young children may have trouble using the information from video to apply to real objects and situations. In a search task, Troseth and DeLoache (1998) hid a toy in a room while children watched. Twenty-four-month-olds who watched through a window were able to find the toy easily while those who watched on a TV monitor had difficulty. A third group was told they were watching through a window, but a TV screen had secretly been moved there. These children (who believed they were watching directly) were able to retrieve the toy better than those who saw the monitor and knew they were watching video. It seems that the way children conceive of video affects their ability to extract and use information presented there. They may see video for itself and have trouble applying its contents to real situations.

The Perceptual Impoverishment Hypothesis

While the dual representation hypothesis focuses on how children *conceive of* and use information on video, the perceptual impoverishment hypothesis focuses on how

children *perceive* information on video. The *perceptual impoverishment hypothesis* (Barr, Muentener, Garcia, Fujimoto, & Chavez, 2007; Barr, in press; Barr & Hayne, 1999) is based on the idea that video does not contain as many perceptual attributes as real, 3-dimensional settings. As a result, when children are presented with a 2-dimensional video, they may not be able to encode a complete 3-dimensional representation of the event. This argument about video rests on studies that have been done on the perception of object unity. Johnson (2000) proposed the threshold model: people need sufficient perceptual information as well as sufficient perceptual skills to segregate object surfaces. Because infants' perceptual skills are not as mature as those of adults, they need more sources of perceptual information (e.g., depth, motion, color, edge cues) to interpret a video display.

Perceptual information present at encoding can also affect later retrieval of a memory. For young children, it is especially helpful when cues present at retrieval match those present during learning. In contrast, older children's memories are more flexible and a less-than-perfect match will facilitate retrieval. For example, Butler and Rovee-Collier (1989) taught 3-month-old infants to kick a crib mobile. Infants were then shown the mobile 1, 3, or 5 days later with either the same crib bumper or a different one. Despite the fact that the main retrieval cue (the mobile) was exactly the same, infants kicked at the crib mobile much less when they had a different surrounding context (the crib bumper), suggesting they had more trouble accessing the memory when contextual cues were mismatched.

Imitation studies with older infants have revealed that as children get older, they are able to use a wider range of potential retrieval cues, and can imitate across greater changes in stimuli and context. For example, Hayne, Boniface, and Barr (2000) showed 6-, 12-, and 18-month-old infants a sequence of behaviors with a puppet. A change in the testing location affected the imitation of 6-month-olds, but this change in context did not disrupt the imitation of 12- and 18-month-olds. Changes in the appearance of the puppet disrupted imitation by 6- and 12-month-olds, but not 18-month-olds. A similar pattern was also found with older toddlers. In a study using a more difficult 3-step sequence of assembling toys, Herbert and Hayne (2000) found that 18- and 24-month-olds did not generalize to toys with surface differences from the originals as well as 30-month-olds

did. In these studies, at increasing ages children were able to use more diverse retrieval cues to access the memory of the original demonstration.

This ability to use diverse retrieval cues helps children apply memories to new situations they encounter. The perceptual impoverishment hypothesis is important because most research focusing on learning from video involves a stimulus-to-retrieval-cue mismatch – children are presented with a real-life (three-dimensional) test of information learned from a two-dimensional video. For example, in a series of studies, (Barr & Hayne, 1999) 12-, 15-, and 18-month-old infants saw an experimenter model target behaviors with a puppet either in person or from a pre-recorded video. Children were shown the actual puppets after a 24-hour delay. Infants who saw a person who was present model the behaviors imitated what they had seen on the first day significantly more than those who saw the modeling on video. Infants in both conditions saw the same puppet both days, but infants in the video condition saw the two-dimensional puppet (on video) on the first day and the real, three-dimensional puppet on the second day. The perceptual impoverishment hypothesis suggests that the missing visual cues may have made it more difficult for the infants to acquire the relevant information from video that would allow them to access the memory when directly given the puppet.

Using the same general imitation paradigm, Barr and Hayne (1999) also presented 15- and 18-month-old children with demonstrations of a three-step sequence of assembling toys. Both 15- and 18-month olds who saw the demonstration on video produced more target behaviors than an age-matched control group. However, they still did not produce as many behaviors as the groups who saw the demonstrations live. The same pattern was found with toddlers. Hayne et al. (2003) repeated this research with 24- and 30-month olds and found that, although their imitation from video was better than the younger children studied by Barr and Hayne (1999), it still was not equivalent to that of an age-matched group who received the demonstration from a live person. In these imitation studies, the same *video deficit* pattern of results was seen using two different tasks.

In the present studies, we used the deferred imitation paradigm to further explore the dual representation and perceptual impoverishment hypotheses. Barr, Hayne, and colleagues had reported a quite consistent pattern of poorer imitation from video by

children around this age; therefore, we expected to replicate their results. However, Troseth and colleagues (and others) had demonstrated that toddlers *could* learn from video under certain circumstances, such as after exposure to live video of themselves (Troseth, 2003; Troseth, Casey, Lawver, Walker, & Cole, 2007) or after engaging in social interaction with the person on video (Troseth, Saylor, & Archer, 2006). In an effort to explore situations in which children do succeed, we examine what attributes of the encoding and retrieval situation allow children to successfully imitate actions learned from video as well as how experience plays a role in how they think about and use video.

CHAPTER II

EXPERIMENT 1

In experiment 1, we set out to replicate Hayne et al.'s (2003) procedures to establish a basis for additional research exploring the circumstances under which toddlers might imitate new skills they have seen on video. We presented children with a 3-step, 3-repetition demonstration using copies of the toys from Barr and Hayne (1999) and Hayne et al. (2003) and tested children after a 24-hour delay. Therefore, we expected to find a similar pattern of results, with 24-month-olds exposed to the live demonstration imitating a higher number of the 3 toy-assembly steps than children who watched the video demonstration. These groups would both have higher imitation than a control group exposed to no demonstration.

Method

Participants

Participants were 39 children between 22 months 9 days and 25 months 18 days of age from a city in the southern US who were assigned to one of three conditions (6 male, 7 female in each): *live* ($M = 24.2$ months), *video* ($M = 24.2$ months), and *baseline* ($M = 24.3$ months). Data from 3 additional children were dropped from the analyses due to: refusal to play with the toys (1), not returning for the second day of testing (1), and experimenter error (1). In all studies reported here, potential participants were recruited through state birth records and parents were contacted by telephone. Families typically identified themselves as White (93.7%), non-Hispanic (97.1%), and middle to upper-middle class. Across the 4 studies, 3.6% of children were identified as Black, 1.8% as Asian, and 0.9% as Native American. Average reported family income was in the \$50,000 to \$75,000 range.

Materials

The stimuli used in all of the studies (Figure 1) were duplicates of those used by Barr and Hayne (1999, Experiments 2-3) with 15- and 18-month-olds and by Hayne et al. (2003) with 24-month-olds. Both toys can be assembled in 3 steps. For the rabbit toy, the ears are raised, the eyes are placed on the Velcro, and the carrot is inserted in the rabbit's mouth. For the rattle toy, the ball is pushed through an opening in the jar lid, the handle is attached to the jar lid with Velcro, and the jar is shaken using the handle.

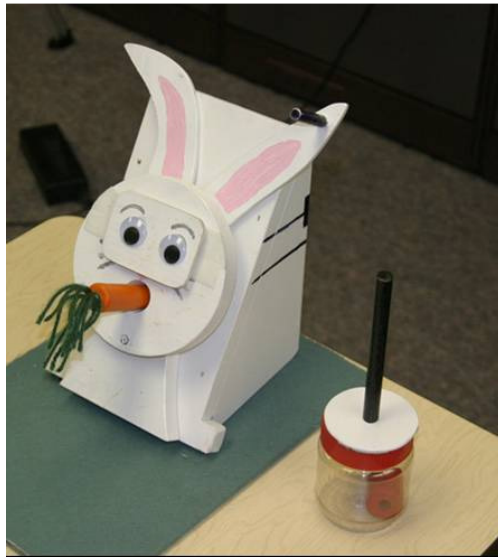


Figure 1: Rattle and rabbit stimulus toys

In Experiments 1 to 3, children were seated at a child-sized table facing either a live person or a 21-inch video monitor, depending on condition. Children in the live condition viewed a person who was present model the sequences, whereas children in the video condition viewed a pre-taped video demonstration (see below) that was played on a DVD player connected to the monitor. Children's behaviors were recorded by a video camera for later coding.

Procedure

The procedure in Experiments 1 through 3 was the same as that used by Barr and Hayne (1999), except that children received the demonstration and test in the laboratory rather than at home. In all conditions, there were two researchers present at any given

time. An *experimenter* who was present on both days interacted with the child and parent. On the first day, a *modeler* of the 3-step sequences was present in the *live* condition, and an *assistant* was present in the *video* condition. On the second day, a *coder* recorded the children's behavior during the test. The same experimenter was present on both days, but the modeler (either live or on video) was never present during the test on day 2. Several different modelers were used in the *live* condition, with two of these also serving as the modelers in the *video* condition.

After a brief warm-up with the experimenter, children were seated at the table across from the modeler or the video monitor, on their parent's lap or with their parent next to them. Children in the live and video conditions saw a demonstration of how to assemble the toys and returned for testing 24 hours later. Children in the baseline condition did not see the demonstration; they participated in the testing only. During the demonstration and test, parents were instructed not to label any of the objects or give their children any hints or help. They also were instructed not to discuss the toys with their children until after the second day of the study.

Demonstration. Children in the *live* group received a demonstration of the 3-step toy assembly directly from the modeler. After drawing the child's attention ("Want to see some toys? Look at this."), the experimenter assembled the toy, made eye contact with the child, said "okay," and then disassembled the toy. The assembly steps were always shown in the same order. This process was repeated three times for each toy, with the modeler looking up and making a brief comment (e.g. "Let's see that again.") after each repetition. Live demonstrations averaged 2 minutes 28 seconds ($SD = 24$ seconds) in duration. Children in the *video* condition watched a prerecorded video of the same demonstration, filmed at the same table against the same backdrop ($M = 2$ min 28 seconds; $SD = 6$ seconds). The order in which the toys were presented was counterbalanced across participant gender and condition.

Testing. Children returned to the lab 24 hours later (in *baseline*, this was their first visit) and were seated at the same table. The experimenter handed them the components of the toy they had seen first on day one, saying, "Look at this! Show me what you can do with this!" Children were given 60 seconds after they first touched the objects to assemble the toy. The other toy was then presented in the same way.

Scoring. In all experiments children were videotaped during both the demonstration and testing sessions. Children's attentiveness to the modeling and their toy assembly were scored in the same manner as in Barr and Hayne (1999). Two independent scorers, one of whom was blind to condition, coded the amount of time children were attentive to the demonstration, and calculated the proportion of total time that children were attentive. In Experiment 1, one child's attention was not scored due to an equipment failure. A Pearson product-moment correlation yielded an inter-observer reliability coefficient of $r(25) = 0.98, p < 0.001$. One scorers also observed each child's imitation behaviors for the presence or absence of the three assembly steps for each toy. Inter-rater reliability with coding that was done online during the sessions was high, Cohen's Kappa = .90, $p < .001$.

Results

Attentiveness

Children were very attentive to both kinds of demonstration, with 22 of 25 attending more than 90% of the time (*live* $M = 96.0\%$, $SD = 4.0\%$; *video* $M = 94.7\%$, $SD = 8.9\%$). A univariate ANOVA with condition as a fixed factor showed that there was no significant difference in attention between these conditions or any of the other conditions reported in Experiments 2 through 4, $F(7,93) = 0.58, p = .77$. Thus, differences in imitation were not due to differences in attentiveness.

Imitation Scores

Children's mean imitation score (0 to 3) was computed for each toy. Preliminary analyses showed no significant effects of age, gender or order on imitation behaviors in any of the studies, so these were not included in further analyses. High baseline scores on the rattle indicated that children did not need the demonstration to successfully assemble the rattle, especially for the first step. As a result, only the rabbit scores (see

Figure 2) were included in the final analyses¹. Planned pairwise comparisons were used because they provide optimal power for pre-stated directional hypotheses. A one-tailed comparison showed that contrary to our hypothesis, scores of the *live* group ($M = 2.31$, $SD = 0.95$) were not higher than scores of the *video* group ($M = 2.15$, $SD = 0.90$), $F(1,36) = 0.23$, $p = .32$, $d = .17$. However, both groups produced significantly more of the assembly behaviors than the *baseline* ($M = 0.46$, $SD = 0.52$) group did, *live* $F(1,36) = 33.66$, $p < .001$, $d = 2.34$; *video* $F(1,36) = 28.29$, $p < .001$, $d = 2.23$.

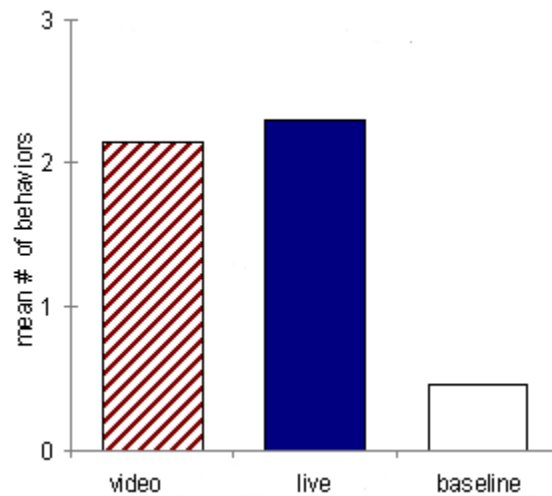


Figure 2: Average number of assembly steps completed (out of 3) in Experiment 1

An examination of children's individual scores revealed that 46% of children in the two modeling conditions imitated all 3 behaviors, whereas none of the children in the baseline condition produced more than 1 of the behaviors.

¹ Children in the baseline condition completed an average of 1.0 out of the 3 rattle behaviors, with 9 of the 12 children completing the first step (putting the ball in the jar). Because this first step seemed to be intuitive to the children in our sample, children only had two remaining steps to imitate from the demonstration. On the other hand, children in the baseline condition only completed an average of 0.46 of the 3 rabbit behaviors, with no more than 3 children performing any given step. As a result, we felt that the rabbit toy allowed more room for children to demonstrate imitation from our demonstrations.

Discussion

Contrary to our prediction and to previous research, we found no difference between the amount of imitation displayed by those children who saw the demonstration live and children who saw the demonstration on video. Our task, which was meant to be a replication of Hayne, Herbert, and Simcock (2003), evidently was somewhat easier for toddlers than the original task. These surprising results are good news, as it is helpful to know that toddlers *can* learn skills from video and are in line with research that presents infants with an easier task. One particular study, done by Meltzoff (1988), found that 14-month-olds could imitate a very simple, 1-step action from video with approximately equivalent performance to a “live” condition reported elsewhere (Meltzoff, 1985).

To investigate our results further, we set out to determine what features of our video or situation might have boosted children’s imitation of the skill. Pinpointing these aspects is important in two ways – first, it helps us gain knowledge of how to use and create videos that children can learn well from; second, these features can shed light on when and why the video deficit occurs in children’s learning from videos.

To do so, we tested the few differences between our procedures and those of Hayne, Herbert, and Simcock (2003). We examined dissimilarities in the *context* in which the videos were filmed and shown, and the *duration* and *pacing* of the videos. In Experiment 2 we changed two aspects of the video demonstration itself.

CHAPTER III

EXPERIMENT 2A

In Experiment 2A, we began to investigate the differences between our video and those used by Hayne et al. (2003) that potentially contributed to differences in children's imitation. Whereas a significant effort was made by both research teams to keep all aspects of the demonstration the same between the live and video conditions, the location of testing affected the match between the contextual backdrop at demonstration and test. Hayne et al. did their experiment in the children's homes, whereas ours took place in the lab. As a result, the backdrop against which Hayne et al.'s modeler was filmed (in the lab) was unfamiliar and did not match the testing location (the child's living room). In contrast, children who saw the live modeler's demonstration saw it in their living room, against a familiar backdrop that was also present during the test session. In line with prior evidence of context dependent learning in infants (Hayne et al., 2000) and adults (Godden & Baddeley, 1980; Smith, Glenberg, & Bjork, 1978), it is possible that 2-year-old children who saw Hayne et al.'s (2003) video demonstration could have had a harder time retrieving the memory of the demonstration, as they were provided with fewer contextual cues during the test than children who saw the live demonstration (the live backdrop matched the test backdrop, whereas the video backdrop did not). In contrast, the contextual background cues in our Experiment 1 (the lab backdrop) were the same for the demonstration and test in both conditions.

To examine whether this procedural difference contributed to a difference in results, we filmed a pre-recorded video in a different setting than that of our laboratory. As a result, children in this video condition saw an out-of-context video filmed in a room that they would not recognize. We predicted that children who saw the out-of-context video would imitate substantially less than children who saw our original video (as had occurred in the earlier research—Hayne et al., 2003). This result would suggest that having the same background context in a video as in the testing situation aided toddlers' imitation of video content, and support this difference as a likely reason for the relative success of the children in the video condition of Experiment 1.

Method

Participants

Participants were 13 children between 23 months 18 days and 25 months 12 days ($M = 24.2$ months; 7 males and 6 females). One additional child refused to play with the toys, so his data was not included in the analyses.

Materials

Children saw a demonstration of the same toys on the same television screen and were tested in the same manner² as in Experiment 1. The video context (background) was the only element of the method that was different.

Procedures

Demonstration. Children in the *context* group received a demonstration of the 3-step toy assembly from a video that was pre-recorded in a different context. During the filming of the stimulus tapes, rather than sitting at the table at which the testing occurred, the modeler sat on the floor between two chairs in a different room. Also, the carpeting and wall color were different. Two modelers filmed videotapes, and the demonstrations lasted an average of 2 minutes 11 seconds ($SD = 3$ seconds).

Testing. Testing was the same as in the previous experiments.

Scoring. The attentiveness and imitation scoring was the same. A Pearson product-moment correlation between the two attention coders yielded an inter-observer reliability coefficient of $r(13) = 0.96, p < 0.001$. Inter-rater reliability between the online coder and a person who scored imitation behaviors from the videotapes was high, Cohen's Kappa = 0.86, $p < .001$.

² Although we did not analyze imitation data from the rattle in any of the experiments included here, we did continue to retain the modeling and testing of the rattle as part of our procedure to keep the task demands consistent across all studies.

Results

Children's mean imitation scores (0 to 3) were computed in the same manner as in Experiment 1. A one-tailed planned comparison established that the level of imitation in the *context* condition ($M = 2.08$, $SD = 0.86$) was not lower than the level of imitation in the *video* condition from Experiment 1, $F(1,60) = .05$, $p = .41^3$, $d = .08$ (see Figure 3).

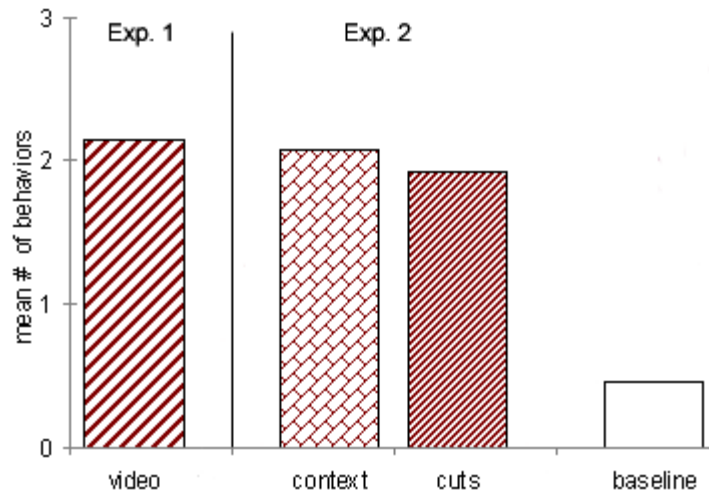


Figure 3: Average number of assembly steps completed (out of 3) in Experiment 2A and 2B

Individual imitation scores in the *context* condition were similar to those of the children in Experiment 1. Around one-third of the children imitated all 3 behaviors, and one child did not imitate at all.

Discussion

In Experiment 2A, we found that changing the backdrop context of the demonstration video had no significant effect on 2-year-old children's imitation of the target behaviors. Children did not need the backdrop of the room to be consistent with the backdrop of the demonstration in order to access their memory about the skill. At

³ Because the comparisons in Experiment 2A and 2B were made to groups already analyzed in Experiment 1, a Bonferroni correction was used to correct for familywise error. As a result, to reach significance a contrast in these experiments needed to reach a significance level of $p < .01$.

least at this age, children's encoding of information from the demonstration video was rich enough to support using the presentation of the toys as a retrieval cue, despite the change in backdrop context. This finding is consistent with the results reported by Hayne et al. (2000) that changes in context affected the imitation of 6-month-olds but not older infants, and in Smith and Vela's (2001) meta-analysis of context-dependent memory research that changes in room did not disrupt memory performance. Therefore, the difference in background in Hayne et al.'s video condition versus their live condition was not a likely factor in explaining why they found a difference in imitation in the two conditions, and we did not.

CHAPTER IV

EXPERIMENT 2B

In Experiment 2B, we investigated the possibility that our video contained more information about the function of the toys than Hayne et al.'s (2003) video did. After communicating with the authors (Simcock, personal communication, March, 7, 2006) and viewing a sample stimulus video, we concluded that Hayne et al.'s video did not put equal emphasis on the assembly and the disassembly of the toys. The main focus of the video was on the three toy assembly steps; toys were disassembled quickly only so they could be reassembled again. In our video, however, disassembly was as slow and deliberate as the toy assembly was, and this may have clarified how the pieces fit together. There is some evidence that information about function and causality are important aspects of children's memory – when an experimenter inserted an event into a sequence toddlers were much more likely to displace or leave out when it was not functionally or causally related (Bauer, 1992; Bauer & Mandler, 1989). In another study, twenty-four-month-olds who saw a video of an experimenter find a hidden object and use it to accomplish a goal successfully retrieved the objects, while children who did not see the objects used to accomplish something, did not (Deocampo & Hudson, 2005). We hypothesized that by using our original videos, but cutting out the toy disassembly, children would receive less information about the function of the toys, and as a result be less likely to reproduce the actions.

Method

Participants

Participants were 13 children between 23 months 15 days and 25 months 9 days ($M = 24.4$ months; 7 males and 6 females). Data from 2 additional children were not included in the final analysis due to experimenter error (1) and parental interference (1).

Materials

Children saw the demonstration on the same television screen and played with the same toys. Only the video demonstration differed.

Procedure

Demonstration. To make the demonstration video for the *cuts* condition, cuts were introduced into the Experiment 1 videos to remove the disassembly of the toys. As a result, children were presented with the modeler's introductory remarks, the 3-step assembly of a toy, the modeler's look up to the camera, a 1/2 second black screen, and then the modeler's comment and assembly of the toy again. All of the speech remained in the video, only the 3-step disassembly of the toy was removed. The demonstrations lasted an average of 1 minute 34 seconds ($SD = 6$ seconds).

Testing. The testing was the same.

Scoring. Scoring was done in the same manner described above. For attentiveness, a Pearson product-moment correlation yielded an inter-observer reliability coefficient of $r(13) = 0.96$, $p < 0.001$. For the scoring of imitation behaviors, inter-rater reliability between the online coder and the person who scored from the videotapes was high, Cohen's Kappa = 0.88, $p < .001$.

Results

A planned comparisons showed that children's mean imitation score in the *cuts* condition ($M = 1.92$, $SD = 1.04$) was not lower than children's score in the *video* condition from Experiment 1, $F(1,60) = 0.45$, $p = .26$, $d = .23$ (see Figure 3).

Individual imitation scores in the *cuts* condition were similar to those of the children in Experiment 1. Around one-third of the children imitated all 3 behaviors, and one child did not imitate at all.

Discussion

In Experiment 2B, we found that removing the disassembly of the toys did not significantly alter children's imitation of the target behaviors. Children imitated the assembly sequence even when they were not provided with the disassembly information.

Although less information about function was provided, children's encoding and retrieval of the demonstration was rich enough to support their imitation of the sequence.

CHAPTER V

EXPERIMENT 3

In Experiment 3, we investigated the possibility that the *duration* of the demonstration may have accounted for our participants' relatively high imitation scores in the video condition of Experiment 1. Although our video included the same number of repetitions of the sequence as the videos of Barr and Hayne (1999) and Hayne et al. (2003), we learned that their videos had a much shorter total duration (1 minute versus 2.5 minutes for our videos)⁴. Perhaps children exposed to an extra minute and a half of demonstration were able to encode more attributes that would help them retrieve the memory later. This could have allowed children in the video group to encode enough additional information that the memory could be accessed just as easily as the memory encoded by children who saw the demonstration live.

In a recently-published set of studies using the same stimuli, Barr et al. (2007) found that younger children (12 to 21 months) imitated more from videos that included more repetitions. Infants either were shown a live demonstration three times (a replication of Barr & Hayne, 1999), a video demonstration *six* times, or no demonstration. Infants in the video and live conditions imitated equally well, and significantly more than infants who saw no demonstration. An additional group of 21-month-olds saw the video demonstration three times. Their imitation fell between that of the infants in the previous conditions: better than infants who saw no demonstration but worse than infants who saw three live or six video repetitions. More exposure to the video stimulus resulted in imitation scores that rivaled less exposure to the live stimulus.

In Barr et al.'s 2007 study, however, both duration and number of repetitions were manipulated. The infants who saw three live repetitions imitated equally as well as infants who saw six video repetitions, but they did not only see more repetitions in the

⁴ A stimulus tape we borrowed from the Hayne lab while designing our experiment used slow pacing of the demonstrated behaviors, similar to ours. However, the tape was from an unpublished study that also included other differences from the published studies discussed here.

video condition – they also saw a *longer-duration* demonstration (60-63 seconds versus 36 seconds). In Experiments 1 and 2, given the slower pace (and thus longer duration – 2.5 minutes) of our video and live demonstrations, perhaps children were getting all of the exposure they needed to excel at the task. Perhaps with longer, slower exposure children do not need additional repetitions from video to learn and imitate the demonstrated skills.

To test this, we exposed children to videos or live events of shorter duration. We chose to shorten our videos by including only one repetition of the toy assembly. We did this to match the pacing and social cues of our original videos, but end up with total demonstration times close to the one-minute length used by Hayne et al. (2003). By reducing both the live and the video conditions we were able to avoid any confound between repetition and duration.

Method

Participants

Participants were 26 children between 23 months 9 days and 25 months 18 days ($M = 24.3$ months; 13 males and 13 females). Data from one additional child was dropped from analysis due to parental interference.

Materials

All of the materials and procedure were the same, except a new, shorter live demonstration or video was used.

Procedure

Demonstration. Children in the *1-demonstration-live* group saw a person demonstrate the 3-step toy assembly and disassembly in a face-to-face interaction, as in Experiment 1, but the modeler demonstrated the sequence only once for each toy. The script for the introduction, the first toy demonstration, the comment made between toys, and the conclusion was kept the same. The script and actions for the second and third repetition were simply removed. These demonstrations lasted an average of 1 minute 7

seconds ($SD = 8$ seconds). Two of the live modelers also recorded videos of the 3-step sequence being demonstrated once, which were shown to the *1-demonstration video* group. These demonstrations averaged 1 minute 8 seconds ($SD = 6$ seconds) in duration.

Testing. The same testing procedure was used.

Scoring. One child's attention was not scored due to an equipment failure, and a second child's attention was only scored by one coder due to a problem with the tape. A Pearson product-moment correlation for the two independent coders yielded an inter-observer reliability coefficient of $r(24) = 0.93, p < 0.001$. Inter-rater reliability between the scoring of the children's imitation behavior by the online coder and the person who coded from the videotapes was high, Cohen's Kappa = .89, $p < .001$.

Results

To examine the effect of demonstration duration on toddlers' imitation, we used a directional planned comparison to examine whether imitation in the shorter, one-demonstration live condition ($M = 2.08, SD = 0.76$) was higher than imitation in the one-demonstration video condition ($M = 1.15, SD = 0.99$). This comparison supported our hypothesis. There was significantly more imitation in the live condition, $F(1, 24) = 7.14, p = .007, d = 1.02$. Imitation in the one-demonstration live condition was similar to imitation in the longer live condition in Experiment 1, but imitation in the one-demonstration video condition was lower (see Figure 4).

Individual levels of imitation in the 1-demonstration live condition were similar to those of the children in the live condition in Experiment 1. Four of the 13 children (31%) imitated all 3 behaviors, and all children imitated at least one behavior. In the 1-demonstration-video condition, only one child (8%) imitated all 3 behaviors, and 4 children (31%) did not imitate any of the steps.

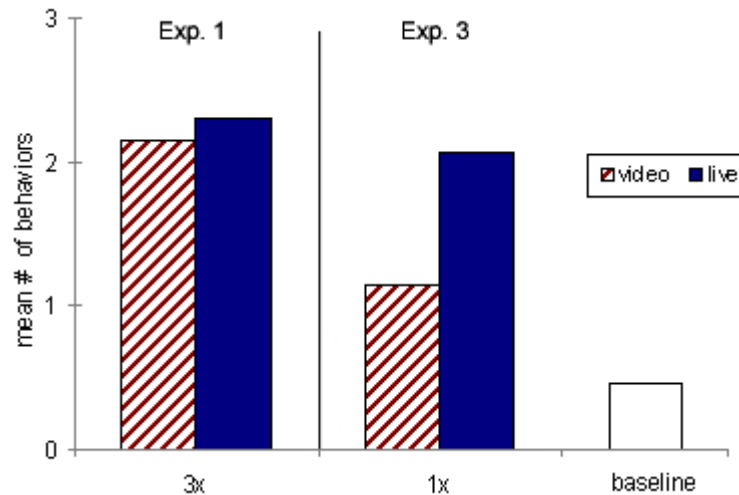


Figure 4: Average number of assembly steps completed (out of 3) in Experiment 3

Discussion

In Experiment 3, we found that the duration of the video had a significant impact on the number of behaviors that children imitated. Although imitation following the shortened live demonstration remained high, imitation following the shortened video demonstration dropped significantly. Because the retrieval cues were the same in this experiment as in Experiment 1 (that is, the situation at test in the two cases was identical), the difference in imitation must have been due to a difference in encoding the information from video.

The duration of our one-repetition video closely matched the duration of Hayne et al.'s (2003) three-repetition video. The pattern of results, the mean scores, and the magnitude of difference in scores between conditions, was the same as in Hayne et al.'s (2003) studies. This suggests that *duration of exposure* may be the key to helping children use information from video, rather than the number of repetitions. With less time to encode the attributes of the demonstration appearing on a video screen, the resulting memory may have contained less information. A future test of this hypothesis would involve manipulating the number of repetitions while keeping the duration of the demonstration constant. One application of such research would be determining the appropriate pacing of human action to use in educational videos designed for very young children.

CHAPTER VI

EXPERIMENT 4

In our final experiment, we explored whether the children in Experiment 1 may have been using information presented in our videos differently because they were not viewing them in the home on their family television set, as was the case in Hayne et al.'s (2003) and Barr and Hayne's (1999) studies. Although much of the research supporting the video deficit has been done in the lab (e.g., Troseth & DeLoache, 1998; Deocampo, 2003; Deocampo & Hudson, 2005; Suddendorf et al., 2007; McCall et al., 1977), the specific studies on which our experiments were based were conducted in the home.

According to the dual representation hypothesis, children may have difficulty thinking about video both as a familiar entity in their living rooms – a source of entertainment and fantasy – and as a potential source of information about real objects. When presented with other types of symbolic objects, like models and math manipulatives, children seem to pay more attention to the use of the object that is highlighted, especially if this use echoes their previous experience with the object. For instance, three-year-old children, who would be expected to easily use a scale model as a symbol, had difficulty doing so after playing with it for 5 minutes (DeLoache, 1987). In another example, five-year-olds had lower letter knowledge and lower understanding of the symbolic properties of letters after playing with a plastic alphabet set than a control group who played with toy shapes (Uttal, Marulis, Lewis, & DeLoache, 2007). Thus, children's prior experience with a symbolic object affects whether they recognize its role as a representation of something else.

As discussed earlier, there is some evidence that this is the case with video as well (Troseth & DeLoache, 1998). A possible explanation for the video deficit is that children's experience with video, in the form of television, sets up expectations about the applicability of information presented there. As toddlers try to make sense of the box with the glass screen in the living room and its ever-changing images, they determine that its contents are inaccessible and often conflict with what they know of the world (e.g., on TV, animals talk) and that the people on screen are not interacting with them (Troseth et

al., 2006). On this account, the video deficit occurs because of toddlers' developing, but incomplete, concept about video.

Children who gain experience with video as a source of relevant information are more likely to use information from a 2-dimensional image to guide their behavior. Troseth (2003) visited 2-year-old children's homes and set up their video camera to display a live feed on their television. Parents were asked to do activities with their children while the children watched themselves on the video. Children then visited the lab and participated in the standard video hide-and-find task. These children were more than 3 times as successful as children in a control group who did not get the special video experience. In this study, there was a huge advantage to having experience with video as a source of relevant, real-time information. For these children, the representational aspect of video had been highlighted, and they responded to the video in the lab as a source of information.

Because children's experience with television happens at home, their expectations about video might have the greatest impact in that setting. The imitation research of Barr, Hayne, and their colleagues (in which children consistently imitated less from video than from a live demonstration) always was carried out in the home, with the video demonstration shown on the family TV set. To examine the possibility that watching the video on the home TV might lower the amount of imitation produced, in Experiment 4 we visited children in their homes and presented them with the original three-repetition demonstrations, using the original video stimulus tapes from Experiment 1 or a live demonstration. We predicted that if watching their family TV highlighted the non-referential, non-informational aspects of video (learned from their prior viewing experience in that setting), that children in the video condition would be less successful than the other group at retrieving and using the information from the screen to help guide their behavior when they were presented with the rattle and rabbit toys a day later.

Methods

Participants

Participants were 26 children between 23 months 6 days and 25 months 27 days ($M = 24.5$ months; 7 males and 6 females in each condition). Nine additional children were dropped for parental interference (3), parent decision not to continue (2, a set of twins), equipment failure (2), lack of cooperation (1), or failure to participate on day 2 (1).

Materials

The same materials were used. Children watched the pre-recorded video from Experiment 1 or received the equivalent live demonstration. However, the demonstrations were presented to the children in their own homes. Children in the *in-home live* condition saw the modeler in their own living room and children in the *in-home video* condition saw the modeler carry out the demonstration on their home television sets.

Procedure

Demonstration. In both conditions, children saw the same three-step demonstration as in Experiment 1, which included three repetitions for each toy. Mean duration was 2 minutes 10 seconds for the live modeling ($SD = 13$ seconds). The videos from Experiment 1 (which were a few seconds longer than the live demonstrations, on average) were used for the *in-home video* condition.

Testing. The experimenters returned to the home 24 hours later. Children were seated in the same room where they had watched the video or live demonstration on the first day and tested in the normal manner. As was the case in Experiment 1, the experimenter was present on both days but the modeler (live or video) was never present on the second day.

Scoring. One child's attention was not scored due to an equipment failure. A Pearson product-moment correlation of the two independent coders' attentiveness scores yielded an inter-observer reliability coefficient of $r(25) = 0.99$, $p < 0.001$. Inter-rater

reliability also was high for the scoring of children’s imitation behaviors, Cohen’s Kappa = .96, $p < .001$.

Results

A planned comparison confirmed that children’s imitation scores in the *in-home live* condition ($M = 2.23$, $SD = 0.93$) were significantly higher than in the *in-home video* condition ($M = 1.38$, $SD = 1.19$), $F(1,24) = 4.08$, $p = .03$, $d = .77$. Children’s mean score in the *in-home live* condition was similar to that of children in the original live condition, while children’s mean score in the *in-home video* condition was lower (see Figure 5).

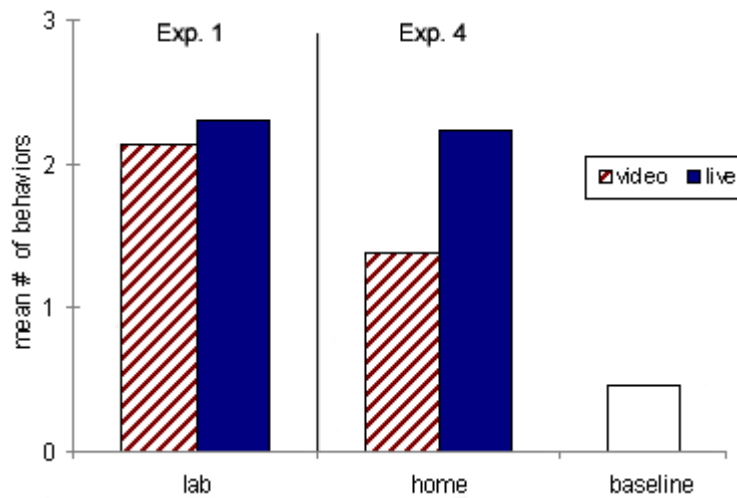


Figure 5: Average number of assembly steps completed (out of 3) in Experiment 4

In the *in-home live* condition, individual children performed similarly to children in the original *live* condition from Experiment 1, with 46% imitating all 3 behaviors and only 1 child imitating none of the behaviors. In the *in-home video* condition, however, only 23% of children imitated all 3 actions and 31% imitated none.

Discussion

Consistent with our hypothesis, we found that children imitated significantly less from the video demonstration in their home environment as compared to the lab environment. Imitation from the live demonstration remained high across both contexts,

showing that the lower imitation from video was not due simply to a change in environment. If, for instance, the home was significantly less memorable of an atmosphere or had more distractions present, then children would have imitated less in both the *in-home live* and *in-home video* groups; but the *in-home live* performance remained high.

The difference in imitation from exactly the same video shown in the lab versus in the home shows that children's prior experience with television likely plays a role in how they respond to and use information presented to them on video.

CHAPTER VII

GENERAL DISCUSSION

The results reported here provide important information about how children learn new skills from video. They highlight the importance of children's experience and give us insight into the circumstances under which children succeed in learning just as much from people on video as from people who are present.

First, the above studies show that very young children *can and do* learn from video and, in some cases, they learn just as well as children do who are given information directly by a person. The video deficit is not always apparent, at least not in children who are two years of age.

Additionally, the above studies suggest that when the deficit does occur, the perceptual impoverishment hypothesis cannot be the full explanation. In Experiment 2A, we showed that changing the background context of the video had no effect on children's ability to imitate new skills. Changing this particular perceptual cue did not disrupt children's imitation of what they viewed on the video. In Experiment 2B, adding cuts to the video (to remove the disassembling of the toys) also did not disturb their imitation. These studies demonstrate that even when a video provides fewer perceptual details to match to the live situation, 2-year-olds can successfully use information presented there to inform their behaviors with real objects.

In Experiment 3, we found that children who saw a shorter demonstration on video, with only one repetition of the assembly information, did not imitate as much as children who got the longer (three-repetition) videos. In contrast, children who saw the shorter or longer live demonstrations imitated at the same (high) level. Following the shorter demonstrations, toddlers exhibited the video deficit pattern (that is, poorer use of information from a video than a live event) shown in other studies. These studies use the same stimuli and a similar short duration, but with three repetitions fit into that short duration (Barr & Hayne, 1999; Barr et al. 2007; Hayne et al., 2003). This result suggests that when there is little time to encode information and store it in memory, the perceptual impoverishment hypothesis may play an important role in children's ability to use

information from video. However, because 2-year-old children imitated quite well from longer videos (in Experiments 1 and 2), they seem to be able to retain and access the information if the video demonstration is long enough. One element of the duration of an event on video is its pace. The three repetitions used in Experiment 1 lasted much longer than the three repetitions used in the earlier imitation studies. A slower pace may be the key to giving children the opportunity to learn as much information as possible from video⁵. Future researchers should manipulate the number of repetitions while keeping the duration constant to help determine the appropriate pacing of actions to use in educational videos.

In Experiment 4, children who were exposed to identical, 3-repetition video demonstrations and tested with identical stimuli in two different settings showed very different levels of imitation based on their environments. Toddlers who saw the video demonstration in their home (on a television set with which they had a viewing history) did not imitate as much as children who saw the demonstration in the lab, away from their normal setting for television viewing. In contrast, those tested following live demonstrations were not affected by setting, consistently imitating at a high level both in the lab and at home. These results support the dual representation hypothesis because they suggest that prior experience can play a role in children's ability to use information from television. Children's experience with non-reality, entertainment-based programming on their home television highlights that function of video so that children do not expect the information on their television to be relevant to objects they will see in real life. Children who have no prior exposure to the lab television, however, do not have this function highlighted, and are better able to represent the video as something that could be a source of potentially useful information.

Children who watch on the lab television (or another unfamiliar television) may still have trouble using information from television, depending on the task. In studies in which children are asked to find a hidden toy (e.g. Troseth & DeLoache, 1998;

⁵ Here we use "pacing" to refer to the speed of human action. A separate issue in media research involves frequent changes in scene and characters, which also may affect children's comprehension and learning from video (see Huston & Wright, 1983).

Deocampo & Hudson, 2005; Troseth et al., 2006) they often do not succeed at applying information given to them on the lab television. This task, however, may be more difficult for children because they need to choose to use the video information over information from their direct experience. After the first trial, they have information about where they last found the toy. In order to successfully use the video information they must choose it over the representation they have formed through actually being in the room. In the deferred imitation task used here, on the other hand, children have no direct experience with the toys prior to the testing period.

Future research should continue to investigate both major hypotheses. As perceptual and contextual cues make more difference in children's ability to access and use memories when they are younger, perceptual impoverishment may play more of a role in younger children's behavior. Research should continue to look at how changing the available perceptual details (e.g. high-definition video) effects how infants use information from video.

With respect to the dual representation hypothesis, research should continue to look at how prior experience may play a role in how children are able to represent and use information presented to them. For example, would children given extensive experience watching cartoons and other un-real videos on the lab television display the same video deficit as children watching these programs at home? Additionally, would younger children display this same experience-based difference?

Infants should not have the same problem of dual representation that two-year-old children have. These children do not have competing representations to choose between because they do not yet think symbolically and do not consider the relation of the symbol to its referent. For example, Pierroutsakos and Troseth (2003) found that 9-month-olds manually explored video objects as if they were real objects. These children tried to grasp at objects on the screen and pluck them out. This type of behavior was replaced by pointing in older children, with 19-month-olds pointing significantly more than 9- and 14-month-olds. Studies with 9-month-olds, then, may be able to examine the video deficit in the absence of the dual representation problem, as infants this young seem to "see through" the video and think of the objects depicted as the same as the real objects themselves.

Another hypothesis has been suggested that may also play an important role in how children learn from video. The social contingency hypothesis focuses on the lack of interactive contingency between the social cues given by people on video and children's responses (Troseth et al., 2006). At four to eight months, children are sensitive to the lack of response when videos of their mother are played back and pay less attention and stop smiling at them (Bigelow, MacLean, & MacDonald, 1996). At least one study shows that adding interactive social components to video may help children use the information presented. Troseth et al. (2006) found that two-year-olds who played interactive games with an experimenter over a live closed-circuit television used video information that was presented to find a hidden toy significantly more often than two-year-olds who watched a pre-taped video of the same games (similar to a television program in which a person talks to the viewing child but cannot respond to the child). Again, giving children experience with video that highlighted its use as either "just another video" or a video that gives information about current real events affected their use of information presented there. Future researchers may attempt to separate these two components to find out if social cues alone may help children to better use information presented on video.

Most importantly, most of the research discussed here focuses on the idea that children do not apply information from video to real tests as well as information given to them directly by people. However, a lot of this research does also find that children do learn *something* from video. Many of these studies include a control group who does not receive instruction, and children who receive video instruction often do better on the tasks than the control group (e.g., some age groups in Barr & Hayne, 1999; Hayne et al., 2003; Barr, et al., 2007). Additionally, video has the potential to reach many young children who otherwise do not have many educational resources. In fact, one of the original goals of Children's Television Workshop was to target a diverse audience, including children from low-income families and those with poor academic performance (Mielke 1994). There is a strong rich/poor achievement gap that follows children throughout their schooling. Before entering kindergarten, the average cognitive score of children in the highest SES group is 60% above the score of the lowest SES group (Lee & Burkam, 2002). However, educational television programs have the capacity to reach

these children even when other resources are not available. According to a 2001 survey, 98.9% of US homes have a color television set, and even in the lowest income bracket, 74% of homes have a VCR (Energy Information Administration, 2004). Although number of books and other child oriented materials and activities like reading and singing with children may be less prevalent in homes where the mother has less education or is on welfare (National Center for Education Statistics, 2000), television is fairly pervasive. As a result, age-appropriate educational programming, especially that shown on the major networks, has the potential to benefit children from a wide range of socioeconomic backgrounds. Research on the video deficit is important because it provides useful information about the best ways to create educationally optimal videos.

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