A US Study of Transfer of Learning from Video to Books in Toddlers

Article *in* Journal of Children and Media · November 2010

DOI: 10.1080/17482798.2010.510013

4 authors, including:


Elizabeth A. Vandewater
University of Texas at Austin


Rachel Barr
Georgetown University

A US STUDY OF TRANSFER OF LEARNING FROM VIDEO TO BOOKS IN TODDLERS
Matching words across context change

Elizabeth A. Vandewater, Rachel F. Barr, Seoung Eun Park and **Sook-Jung Lee**

Few empirical studies of word learning from video during toddlerhood have been conducted. Children aged 18 to 33 months viewed a 10-minute commercially available video about different shapes daily for 15 days. The experimental group video included the novel word and shape crescent; the control group video did not. The experimental group was significantly more likely to correctly point to the crescent shape at test than children in the control group. Groups did not differ on four other high frequency shapes (square, circle, rectangle, triangle) that were included in both videos. Results indicated that toddlers were able to learn a novel word from video and apply that information in a different context. Results are discussed in the terms of the cognitive challenge of transfer of information across context and the ecological validity of ongoing research on young children's ability to learn from video.

KEYWORDS infant-directed videos; labeling; repetition; television; toddlers; word-object association

The last few decades have seen a booming market of baby videos/DVDs aimed at babies between birth and 36 months of age (e.g. *Baby Einstein*®, *Brainy Baby*®, and *Sesame Beginnings*®), the launching of the entire television networks specifically targeting children as young as 12 months (i.e. *BabyFirst TV*), and a multimillion-dollar industry selling computer games for children as young as 9 months (e.g. *Jumpstart Baby*, *Baby Wow*). According to recent US national survey studies, these products have enjoyed enormous levels of popularity (Rideout & Hamel, 2006; Rideout, Vandewater, & Wartella, 2003).

There are however, cross-cultural differences in the amount of children's television exposure, with US samples reporting higher levels of exposure than European samples. In particular, more than 70 per cent of US 3-year-old children were exposed to television more than 2 hours per day (Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004), whereas less than 6 per cent of Danish 3-year-olds had comparable levels of daily exposure (Obel et al., 2004). Based on concerns that television exposure may disrupt the quality and quantity of parent–child interaction, the American Academy of Pediatrics (AAP) currently recommends that children under the age of 2 avoid exposure to screen media altogether and that the viewing time of children over two be limited to no more than 2 hours a day (AAP, 2001).

However, it is clear that few families follow this recommendation. A recent report conducted in the United States indicates that children aged 0–6 years spend an average of 1 hour and 43 minutes viewing television, videos, or DVDs, and fully one third of them have a

Journal of Children and Media, Vol. 4, No. 4, 2010
ISSN 1748-2798 print/1748-2801 online/10/040451-467
 DOI: 10.1080/17482798.2010.510013

television in their bedroom (Rideout & Hamel, 2006). Vandewater and colleagues found that only 30 per cent of parents of children under the age of 2 actually follow the AAP's screen time guidelines (Vandewater et al., 2007). Rideout and colleagues (2003) reported that parents appear to have a great deal of faith in educational videos, with about half (49 per cent) saying they consider them "very important" to children's intellectual development.

Virtually all companies creating media and technology for the infant and toddler market claim or imply that their products are educational. Clearly, these products have hit a chord with parents, as the popularity of both *Brainy Baby*® and *Baby Einstein*® videos will attest. Yet, none of these companies has actually empirically evaluated the efficacy of their products (Garrison & Christakis, 2005). Given this, what do we actually know about the developmental consequences of media and technology use for young children?

Learning from Commercially Available Programs

Evidence from studies of children aged 2 and older strongly supports the notion that high quality educational programming has positive impacts on children's language, academic skills, academic engagement, and attitudes toward learning (Anderson, Huston, Schmitt, Linebarger, & Wright, 2001; Bickham, Wright, & Huston, 2001; Huston & Wright, 1997; Schmidt & Anderson, 2006; Schmidt & Vandewater, 2008). The preponderance of evidence regarding the impact of media on children aged 2 and older indicates that program content is key—with children learning specific behaviors from specific curriculum.

Schmidt, Rich, Rifas-Shiman, Oken, and Taveras (2009) conducted a prospective study examining the relationship between television exposure at 6, 12, and 24 months and language and motor skills at age 3. After controlling for multiple demographic factors, including maternal education, and income, television exposure had neither a positive nor a negative association with language and motor skills. The authors acknowledged that a limitation of the study was that they did not consider the content of the television exposure. Other studies have demonstrated that specific content may be associated with both positive and negative outcomes.

Schmidt, Pempek, Kirkorian, Lund, and Anderson (2008) report that exposure to adult-directed programming, such as sitcoms, game shows, or current affairs, interferes with infants and toddlers' complex play behavior. The authors are careful to point out that such adult-directed programming is largely incomprehensible to young children, and that these findings may not apply to programs specifically designed for infants and toddlers.

Zimmerman, Christakis, and Meltzoff (2007) also reported a negative relationship between language development and the viewing of video programs but in this case the negative association was between viewing programs specifically designed for infants and toddlers and language development. Each hour of viewing videos/DVDS designed for infants and toddlers was associated with an eight to ten word decrease in receptive vocabulary among 8- to 16-month-olds. They found no relationship between language development scores and infant video/DVD viewing among older children (aged 17–24 months). Though intriguing, it is important to note that though the researchers asked about infant video watching in general, they did not differentiate the content of the infant video watched. Thus, for example, music-based videos, where no words are presented or spoken, and language-based videos, where words and objects are presented and identified, were grouped together.

Linebarger and Walker (2005) carefully examined the specific programs that infants viewed between 6 and 30 months in a longitudinal study to trace the relationships between exposure to specific television shows and vocabulary growth. They found that at 30 months of age, cumulative hours of watching *Dora the Explorer*, *Blue's Clues*, *Arthur*, *Clifford*, or *Dragon Tales* prior to and at 30 months of age was associated with larger vocabularies and higher expressive language use scores, but watching *Teletubbies* was related to smaller vocabularies and smaller expressive language use scores, when controlling for parent's education, child's home environment, and child's cognitive performance. They concluded that, much like for preschool children, program content guides the kinds of things infants learn. The narrative programs targeted children aged approximately 4 to 7. It is possible that narrative might have been responsible for vocabulary growth, but it could also be that more sophisticated children were attracted to programming for slightly older audiences.

Unfortunately, existing studies that have found positive and negative associations with specific content have utilized correlational rather than experimental data. Thus, it is impossible to know whether viewing of infant videos causes delayed language development or whether children with delayed language development watch more infant videos, and, conversely, whether watching more complex narrative shows causes enhanced language or whether children with more sophisticated language skills are attracted to programming for slightly older audiences.

Most recently, researchers have taken a slightly different approach to examine whether infants can learn from commercially available programming by conducting training studies. They asked parents to expose infants to specific commercial programs and then measured language acquisition. In two recent studies of word learning from commercially available programs (DeLoache et al., in press; Robb, Richert, & Wartella, 2009), 12- to 18-month-old infants and their parents repeatedly viewed commercially available videotapes for 1 month. Robb et al. (2009) assessed word learning in 12- to 15-month-old infants from *Baby Wordsworth*, a video in the *Baby Einstein* series designed to teach children a set of thirty specific vocabulary items. The home-viewing group watched the video five times every 2 weeks for 6 weeks, but did not show improved production or comprehension of these words as measured by parent report when compared to controls. In contrast, time spent sharing books was associated with an increase in both receptive and expressive knowledge of the vocabulary list.

In a similar study, DeLoache and colleagues (in press) found that the vocabulary knowledge of 12- to 18-month-olds did not increase as a result of DVD viewing, when compared to controls using a forced-choice measure. A group exposed to the same set of words by their caregivers, however, did show increased knowledge of the vocabulary. Overall, vocabulary levels were not enhanced by exposure to these specific infant-directed videos in this age range even though vocabulary increased as a result of face-to-face interactions and book-reading.

Findings from studies involving repeated exposure to DVD content in the home across extended periods of time are consistent with studies using experimental stimuli to assess learning from video. All consistently find that infants and toddlers learn better from real-life experience than from video—this has been termed the video deficit effect. This "video deficit" disappears by about age 3, when learning from video becomes more robust (Anderson & Pempek, 2005; Hayne, Herbert, & Simcock, 2003) but depends upon the complexity of the to-be-learned material (Flynn & Whiten, 2008). Support for the video deficit hypothesis comes from several lines of research such as studies regarding deferred imitation (Barr & Hayne, 1999), learning from emotional cues (Mumme & Fernald, 2003), search behaviors (Schmitt & Anderson, 2002), and vocabulary learning (Krcmar, Grela, & Lin, 2007). This is hardly surprising, and few would claim that video can replace quality interaction with parents with respect to learning in very young children. However, given that most young children are exposed to video content designed for them, it seems reasonable to ask under what conditions *can* young children learn from video?

Experimental Stimuli

Because of the striking dearth of experimental studies examining the impact of commercially available programs aimed at infants and toddlers, the answer to this question is we don't really know. However, a small but growing number of studies have used novel experimental stimuli to disentangle the effects of repetition and verbal cues on learning from video (e.g. imitation, forced-choice; for recent review see Barr, 2008).

Krcmar et al. (2007) examined whether 15- to 24-month-old infants could fastmap novel words presented on video and match the words to real 3-D objects. They contrasted learning from a commercially available video with an experimentally produced video. In a repeated measures design to assess whether infants could match a still 2-D image with the corresponding 3-D image, they examined word learning under five experimental conditions; (1) adult video—a video clip with an adult speaker labeling one of five novel objects, such as a whisk; (2) children's television video—a voiceover on the children's program *Teletubbies* labeling one of the same five objects; (3) adult live joint reference—an adult labeled one of five objects when the toddler was attending; (4) adult live discrepant reference—an adult labeled one of five objects when the toddler was not attending; and (5) no word control condition. During the labeling phase, the object was labeled five times using a novel word like "mope" in the presence of four other distractor objects. At test, infants were asked to give the experimenter the "mope."

There were a number of important findings. First, the control condition data revealed that infants were able to match a 2-D image to the 3-D object as early as 15 months. Second, they found learning in the adult video condition was similar to children's performance in the adult live joint reference condition. Third, learning from the children's television program was significantly worse than the adult live joint reference condition and similar to the adult live discrepant reference condition. This finding was qualified by an Age × Condition interaction that indicated that children younger than 22 months did not learn words from the children's television program but were able to learn a novel word in the adult live joint reference condition.

The authors concluded that learning was maximized by face-to-face interaction in a joint reference context. Although they were able to match 2-D depictions and 3-D objects, infants continued to exhibit a video deficit effect at least when the novel words were embedded in a commercially available television program. Krcmar et al. (2007) argued that learning may have been impaired because the children's television program contained too much information. Infants under 22 months were not able to attend to the relevant information in order to parse out the novel word in a fast mapping task, and learning from the adult on video may have been easier because there were fewer distracting stimuli. In this way, the adult on video condition more closely mimicked the live face-to-face interaction. When the stimulus characteristics are fitted to the viewer's current cognitive capacity and are also directed at the viewer in a pseudo-face-to-face context, it appears that infants and toddlers can learn at levels similar to the actual face-to-face context. In contrast, learning from commercial programming may be more difficult than learning from experimentally produced stimuli because commercial programming contains more complex formal features, including cuts, sound effects, music tracks, and processing of formal features that requires working memory (Kcrmar et al., 2007; Scofield, Williams, & Behrend, 2007). The authors suggested that because working memory is limited during toddlerhood, infants' ability to extract novel words from the more complex children's television program decreased and a video deficit occurred.

In the study conducted by Krcmar and colleagues (2007), infants only viewed the videos on one occasion. Linebarger and Walker (2005) argue that experiments using one trial of a televised stimulus provide little evidence of learning from screen, as the relationships between television viewing and learning are the result of accumulated experiences at home. Consistent with the argument that working memory ability is involved in transfer of learning, there are several studies suggesting that the video deficit can be ameliorated for 1- to 2-year-olds when the demonstration of the target actions was repeated (Barr, Muentener, & Garcia, 2007; Barr, Muentener, Garcia, Fujimoto, & Chavez, 2007; Barr & Wyss, 2008) and when toddlers have interactive experiences with television (if, for example, they converse with an experimenter via closed-circuit video) (Troseth, Saylor, & Archer, 2006).

Barr and Wyss (2008), for example, examined whether infants would apply novel labels to objects if the labels were presented on television or if they were presented by parents. Two-year-olds were randomly assigned to a voiceover video group, a parent-mediated video group, a parent-mediated live group, or a baseline condition. Infants in all three experimental conditions imitated significantly more target actions than did those in the baseline control condition with no differences between these experimental conditions. That is, 2-year-olds were able to use novel labels to solve a difficult imitation task regardless of whether the television or the parent provided the label. Whether such labeling is similarly effective at younger ages is not known (Hayne et al., 2003).

Finally, Ganea, Bloom Pickard, and DeLoache (2008) found that 15- and 18-month-olds were able to point to a novel object (e.g. wire egg cup) when it was labeled in a book and to point to the same picture in the book when the object had been labeled. The label was a nonsense label (e.g. blicket). There was an age-related increase in performance between 15 and 18 months. Infants also found it easier to match the label to the picture when photographs were used than when cartoon depictions were used. Ganea and colleagues argued that transfer of information from the book to the real world and vice versa was facilitated by the degree of overlap in features across context.

Taken together, this nascent literature is intriguing but incomplete. Mapping of verbal labels to real objects from video and books during toddlerhood seems possible under some conditions (Ganea et al., 2008; Krcmar et al., 2007; Linebarger & Walker, 2005; Scofield et al., 2007), but not under others (DeLoache et al., in press; Robb et al., 2009). It may be worth noting that in studies where learning from video was observed, novel word labels (e.g. meewa) and unusual objects (e.g. whisk) were used (Barr & Wyss, 2008; Ganea et al., 2008; Krcmar et al., 2007; Scofield et al., 2007), whereas in studies where word learning was not observed familiar labels and objects were used (e.g. table) (DeLoache et al., in press; Robb et al., 2009). Thus, it is possible that the use of familiar objects and words may have masked word learning during a developmental period of rapid word acquisition.

The Present Study

The purpose of this study is to evaluate whether toddlers can map a novel label and point to a novel shape—the crescent—after repeated exposure to a video designed to teach this shape. Taking a similar approach to Krcmar et al. (2007), the present study will therefore examine the ability of infants and toddlers to map a novel word that has been embedded in a commercial program to a corresponding picture of the object. To increase the ecological validity of the study, the 10-minute video clip borrowed components directly from *Brainy Baby*® *Baby Shapes & Colors* video, had the same teaching style as the commercial video product, and was shown in the home under naturalistic conditions on repeated occasions across a 15-day period. Christakis (2009) in his review of the literature argued that experimental investigation of specific commercially available video content was necessary to answer whether or not toddlers can learn from video. Unlike prior studies, the present study experimentally manipulated a commercial video program. To control for the effects of familiarity, we presented both familiar shapes (e.g. square, circle) and an unfamiliar shape (crescent). The unfamiliar shape was presented only to the experimental group. We chose the crescent because it is a novel shape to most US children, and parents are less likely to teach it than they are the other shapes tested, which are commonly taught to children starting at a very young age. We collected a parent report vocabulary measure and a direct infant forced-choice measure. Our participants ranged in age from 18 to 33 months. The forced-choice task is a robust task for toddlers and this is also a typical time during which shape learning occurs and there is a typical vocabulary spurt from 18 months onwards, making it a theoretically relevant age group in which to study word learning.

We tested the following hypotheses:

H1: Children in the experimental condition will be significantly more likely to point to the crescent shape after hearing the label crescent than those in the control condition.

H2: Children in the experimental condition will be no more likely to correctly point to the four other test shapes (triangle, circle, square, rectangle) than children in the control condition.

Method

Participants

Forty-one families were recruited in Austin, Texas and surrounding areas through local on- and off-campus newspaper advertisements and flyers placed in libraries and childcare centers. Toddlers (twenty-four girls, seventeen boys) ranged in age from 18 months to 33 months, with a mean of 24 months 12 days ($SD = 4.0$ months). Participants were African-American ($n = 5$), Asian or Pacific Islander ($n = 2$), Caucasian ($n = 28$), Latino ($n = 4$), or other ($n = 2$). The mothers' mean educational attainment was 16 years, 2 months ($SD = 8$ months), and the mean family monthly income of \$6,397 ($SD = \$4{,}792$). Participants were randomly assigned to one of two conditions; experimental ($n = 20$) and control ($n = 21$) as they became available for testing. A randomization check confirmed that there were no significant differences among toddlers in the control or experimental group on any measure of child or family background characteristics. Testing was discontinued on additional infants for withdrawal due to incompletion of the exposure phase of the study ($n = 17$) and failure to respond to any of the forced-choice prompts ($n = 2$).

Materials

An experimental 10-minute clip was created which included components from *Brainy Baby's® Baby Shapes & Colors* DVD as well as additional components produced for the study using the same teaching style. *Brainy Baby's® Baby Shapes & Colors* DVD features lessons regarding the shapes of the circle, square, rectangle, triangle, and crescent. The DVD pairs visual representation of each shape with voiceovers labeling the shapes by name. The control group DVD clip was also 10 minutes in duration, but references to and representations of the crescent were removed and replaced with a clip of puppets dancing, to equate exposure time to the video.

A parent viewing log was developed to record the number of times toddlers were exposed to the video each day and the number of minutes toddlers were actually attending to the video when watching.

Language production was measured via the Level II 100-word short form of the MacArthur Communication Development Inventory (MCDI; Fenson et al., 2000) and in addition parents indicated whether or not toddlers produced specific shape words.

A six-item picture book contained pictures of the shapes as they appeared in the videos. The first item was a practice page that had a photo of a dog and a cat. Items 2 to 6 contained pictures of shapes. Each shape was presented with another shape, such that children had a 50 per cent chance of pointing to the right or the wrong shape. The test items were placed in a binder such that the order of test items could be counterbalanced across participants.

Procedure

Viewing period. Parents were asked to show toddlers their respective 10-minute video clip at least once every day for 15 days. Parents logged the number of times their toddler watched the video each day and the number of minutes toddlers were actually attending to the video while it was playing.

Language assessment. Parents completed the 100-item short-form MCDI (Fenson et al., 2000) before and after the viewing period. Parents also reported whether or not the toddler could say each of the shape names before and after the viewing period. The parent report of shape labels provided a pre- and posttest measure of productive vocabulary for specific shapes.

Forced-choice test. Once the viewing period was over, toddlers were brought to the lab for testing. Toddlers were given a roughly 10- to 15-minute warm-up period to help them feel comfortable in the room and with the experimenter. The researcher and the toddler sat on a blanket on the floor, and the caregiver sat nearby either on the floor or on a chair. Toddlers were considered to be comfortable with the experimenter after they made eye contact and handed the experimenter an asked-for item. This also ensured that the toddlers were able to follow simple instructions. All did so. Toddlers then watched the last 3 minutes of the research video, which is a review of all the shapes. This ensured that one presentation of the crescent shape did not result in learning the label but rather repeated presentations were required.

Toddlers then participated in the forced-choice test using a six-item test book, still sitting on the floor with the experimenter using a seminaturalistic book-reading test condition. The first pages had two familiar pictures, a photo of a dog and a cat. The first trial was a practice trial. Children were asked to point to the cat and the dog. All children successfully completed the practice trial. The following pages contained the actual shapes.

Toddlers were given five forced-choice tests; order was counterbalanced across participants. Toddlers were asked to match the label provided by the experimenter to the correct shape by pointing to the matching shape in a picture book that contained pictures of the shapes as they appeared in the videos. Toddlers were asked to point to one of two pictures after hearing the following five shape labels: crescent, triangle, circle, rectangle, and square. Each shape was presented with another shape, such that toddlers had a 50 per cent chance of pointing to the right or the wrong shape. The experimenter said "Can you show me the [shape]?" at the beginning of each trial. Toddlers were presented with one page at a time until they identified the shape by pointing to it or touching it, or until they moved away or cried, defined as did not respond. Three to six children did not respond on any given trial (8–15 per cent of trials) and nonresponse rates did not differ as a function of shape or experimental condition. Due to an inability to interpret nonresponses, they were not included in the data analysis.

Results

Coding

For a child in the study to be counted as being able to transfer the shape label to the correct picture on each trial, they had to respond to the label by correctly pointing to the matching shape. For example, if the label was crescent, the child responded correctly if s/he pointed to the crescent picture. The dependent variable was the first point to one of the two pictures.

Descriptive Statistics

Parents were compliant with instructions and showed the video at least once per day. The attended minutes were averaged across the 15 days. On average parents reported that their children attended to the video for 10.6 minutes per day ($SD = 6.4$) and there was no difference between the amount of time that those in the control group attended ($M = 11.5$ minutes, $SD = 7.7$), and the experimental group attended ($M = 9.6$ minutes, $SD = 4.7$), $t(39) < 1$. Note the number of minutes per day is greater than 10 because some parents showed the video clip more than once. Language development in this sample was typical; on average the percentile rank on the MCDI was 41.4 ($SD = 28.90$) at the time of the test and did not differ as a function of experimental condition. Two parents in the experimental group did not complete the language inventory.

Forced-choice Performance

Table 1 shows the percentage of children who correctly identified each shape as a function of experimental condition. In order to examine differences between the experimental and control groups, we conducted separate logistic regression analyses predicting correct choice of each of the five shapes separately. Table 1 also presents correct response for each shape. Analysis using Kruskal-Wallis independent samples nonparametric *t*-tests comparing performance of the experimental and control group across shapes were identical to the logistic regressions; thus, we present only the logistic regression results. As predicted, the experimental group was significantly more likely to point to the crescent than the control group when the experimenter asked the child to point to the crescent. Specifically, compared to the control group, infants in the experimental group were twenty-two times more likely to correctly point to the crescent. Controlling for frequency of exposure to the video, age of the child, and vocabulary production of the child, children in the experimental group continued to be significantly more likely to point to the crescent than children in the control group (OR = 26.02, CI = 2.30–293.88). Furthermore, nonparametric binomial tests showed that children in the experimental group pointed to the crescent shape significantly more than chance ($p = .001$, Fishers exact test) but children in the control group did not ($p = .84$, Fishers exact test). Finally, parent report also indicated that there was a group difference in children's production of the word crescent. Before the video exposure parents in both the experimental group ($M = 0.20$, $SE = 0.09$) and control group ($M = 0.10$, $SE = 0.06$) reported that few of their children produced the word crescent. That is, parents confirmed that the word crescent was unfamiliar to infants ranging from 18 to 33 months. After the video exposure, however, parents in the experimental group ($M = 0.63$, $SE = 0.11$) were significantly more likely than parents in the control group ($M = 0.15$, $SE = 0.08$), to report that their children produced the word crescent, $t(37) = 3.50$, $p < .001$. Both parent report and children's behavior on the forced-choice procedure were consistent with the conclusion that the experimental group learned the label to shape correspondence for crescent but the control group did not. Furthermore, a single presentation of the crescent shape during the reminder at the beginning of the test session was not enough for the control group to learn the shape; repetition was necessary. As expected, there were no significant differences between the groups on the ability to point to any other shape after the experimenter provided the label. In fact, most children did very well on the other four shapes (see Table 1).

TABLE 1
Percentage of children point to correct shape as a function of experimental condition and odds ratio and confidence interval from logistic regression predicting matching of label to correct shape as a function of intervention condition

Shape		Control	Experimental	Odds ratio
Crescent**	Incorrect	55.00%	5.26%	22.00**
	Correct	45.00%	94.74%	(2.44–198.14)
Square	Incorrect	23.53%	0.00%	2.39
	Correct	76.47%	100.00%	(1.50–3.60)
Circle	Incorrect	15.79%	11.11%	1.50
	Correct	84.21%	88.89%	(0.22–10.22)
Rectangle	Incorrect	27.78%	15.79%	2.05
	Correct	72.22%	84.21%	(0.41–10.24)
Triangle	Incorrect	16.67%	10.00%	1.80
	Correct	83.33%	90.00%	(0.27–12.23)

Note: $^{**}p < .01$. Confidence interval in parentheses.

Discussion

The present study assessed whether toddlers were able to learn a novel word and match it to a shape from a video clip based on *Brainy Baby's* ® *Baby Shapes & Colors* video. It represents one of the first studies conducted to experimentally manipulate commercial video content to assess toddler learning from video. It also represents one of the first studies to examine transfer of learning from video to another 2-D symbolic medium, a book. The present findings replicate and extend those studies that have used experimental stimuli to examine factors that influence the video deficit by conducting a study under more ecologically valid conditions. Infants in the experimental condition were significantly more likely to point to the crescent shape than infants in the control condition. Groups did not differ, however, on four other more common shapes that were presented in both the experimental and control videos.

There are three noteworthy findings from this study. First, we found that the specificity and novelty of the content was critical in demonstrating learning from video during toddlerhood. Second, the learning strategy used here, and in a commercially produced video, whereby a simple visual image is matched with a verbal label may be less taxing of working memory and therefore more appropriate for young children (Krcmar et al., 2007). Third, the use of a novel piece of information unmasked learning such that there was no difference between groups with familiar objects but there were between-group differences with the novel shape. This occurred during a period of rapid word acquisition and performance was measured during a demanding cognitive transfer task. These findings have important implications for experimental design to answer questions regarding learning from media during infancy.

The present study empirically demonstrated that toddlers learned specific and novel content from video specifically designed to teach that content. Findings from previous studies examining the mapping of verbal labels to real objects from video during toddlerhood have been mixed, with some indicating that it is possible (Krcmar et al., 2007; Linebarger & Walker, 2005), and others indicating that it is not (DeLoache et al., in press; Robb et al., 2009). The findings here suggest that the use of familiar objects and words may have masked word learning during a period of rapid word acquisition and a demanding cognitive transfer task.

It is likely that transfer was successful for a number of reasons. First, infants were 18 months and older and therefore their memory representations are beginning to be more flexible and their ability to fastmap labels to objects is rapidly developing (Bloom & Markson, 2001; Hayne, 2004, 2006). Second, the transfer task from the video to the book resulted in few perceptual changes to the stimulus except for the physical location of the stimulus. This minimal perceptual difference allowed for maximal matching of retrieval cues across the video to book context (Barr & Hayne, 1999; Ganea et al., 2008; Suddendorf, 2003). Third, infants had a great deal of repeated exposure to the test stimuli and such repetition is likely to facilitate transfer across context. These findings are consistent with experimental and observational studies demonstrating that repetition facilitates toddlers' and preschoolers' comprehension of televised material (Barr, 2008; Barr, Muentener, & Garcia, 2007; Barr, Muentener, Garcia, Fujimoto, & Chavez, 2007; Barr, Zack, Garcia, & Muentener, 2008; Krcmar et al., 2007). In the present study, infants repeatedly viewed the video content, logging on average 150 minutes of exposure to shape material.

Given that educational tools primarily assume that there will be a transfer of information from symbolic media to the real world (for review, see Barnett & Ceci, 2002), the lack of research on transfer of learning across media context during early childhood is surprising. Learning across context has been empirically examined with infants using operant conditioning procedures (Hartshorn et al., 1998; Hayne & Findlay, 1995; Hayne, Rovee-Collier, & Perris, 1987) and with toddlers using the imitation paradigm (Barnat, Klein, & Meltzoff, 1996; Hanna & Meltzoff, 1993; Hayne et al., 2003; Hayne, Boniface, & Barr, 2000; Hayne, MacDonald, & Barr, 1997; Herbert & Hayne, 2000). In operant conditioning procedures, for example, infants learn to move a train around a track by pressing a lever. At 6 months of age a change in the room in which the game was learned interferes with memory retrieval, but by 9 and 12 months this context change does not interfere with retrieval. In the deferred imitation paradigm, infants are shown a novel action on an object and asked to reproduce that action after a delay. Similarly, at 6 and 12 months of age a change in the puppet from a rabbit to a mouse disrupts memory, but such a change does not disrupt imitation by 18-month-olds. These studies show that transfer of learning across different locations and different objects increases gradually with age. This is confirmed in a recent study by Roseberry, Hirsh-Pasek, Parish-Morris, and Golinkoff (2009), who found that younger children can only learn verbs from video with live social interaction, whereas older children can learn verbs from video alone.

In the present study, we examined the implicit assumption that upon viewing *Brainy Baby's®* *Baby Shapes & Colors* video, infants will transfer information about shape names and shapes from the video to the real world. Similar to Ganea and colleagues (2008), the findings here indicate that toddlers transferred specific content knowledge from the video demonstration to a book, using a common label. As mentioned earlier, this flexibility in transfer of information beginning around 18 months is consistent with the development of an increasingly flexible representational memory system (Hayne, 2004) and fastmapping of labels to objects (Bloom & Markson, 2001).

The mapping of a label to an object from video to a book context involves two challenging cognitive processes. The first is transfer across symbolic media and the second is matching labels to objects. Both processes have protracted developmental trajectories. First, processing information from 2-D may emerge earlier than transferring information from video to real-world contexts (Hofer, Hauf, & Ashcherleben, 2007; Zack, Barr, Gerhardstein, Dickerson, & Meltzoff, 2009). Similarly, researchers using event-related potentials (ERPs) have demonstrated that 18-month-olds process 2-D images more slowly than they process 3-D objects, recognizing a familiar 3-D object very early in the attention process and recognizing a 2-D digital photo significantly later (Carver, Meltzoff, & Dawson, 2006). The second process is the complex task of matching of verbal labels to objects, which develops at approximately 14 months of age (Werker, Cohen, Lloyd, Casasola, & Stager, 1998). In the present study, infants were able to process all these symbolic relations at 18–24 months.

Future Research

A number of questions for future research arose from the present study. Future studies should investigate the performance at younger ages to assess whether younger infants could similarly transfer information. Additionally, examining the generalizability of the findings beyond the exact representations that were shown on the video (for example, other versions of a shape) will be an important area of future study. Future studies could also adapt habituation and imitation procedures to examine transfer of word–object associations from video to the real world during infancy, as well as utilizing the forced-choice procedure during toddlerhood. All parents were compliant with experimenter instructions and we did not find a significant effect of exposure on learning. Finally, future studies should titrate the exposure required to exhibit learning.

The second key element to the present study was that the video used a simple labeling strategy pairing information to be learned in a simple visual format matched to a voiceover verbal label and may be more conducive to learning in toddlers given the limited working memory ability in this age range (Krcmar et al., 2007). Studies that use experimental stimuli have similarly shown that simple labeling and repetition ameliorate the video deficit effect (Barr & Wyss, 2008; Krcmar et al., 2007; Scofield et al., 2007). Future research should focus on identifying ecological factors as well as content-related factors that might be predictive of learning from videos. In particular, researchers should examine factors that might affect working memory demands, including systematic variation of formal features, including pacing, pans, and cuts.

The present results along with those of Krcmar and colleagues (2007) suggest that decreasing working memory demands by using simple matched labeling strategies, without a large number of formal features may enhance learning from video by toddlers. It is not clear how pacing or specific formal features would serve either to increase or to decrease working memory demands. For example, Fisch (2004) noted that formal features such as close-ups or pans can be used to focus viewers' attention on information relevant for comprehending on-screen content. Recently, Barr, Somanader, and Wyss (2009) reported that sound effects neither enhanced nor interfered with learning from video during infancy. Presumably, reducing on-screen distractions through the use of formal features such as close-ups would also reduce demands on working memory. The relationship between looking time and comprehension is likely to be complex when commercial programming is utilized in studies and more sophisticated methods of looking and attention may also be required for thorough data analysis (see Courage & Setliff, 2009).

Finally, the overall structure of commercially available programming and its relation to vocabulary learning and other cognitive tasks requires further empirical investigation. In the present study, the simple matched label to visual presentation style in the video promoted shape identification. In other studies, for instance, Linebarger and Walker (2005) found that positive vocabulary growth was associated with content that had strong narratives (e.g. *Clifford*, *Arthur*) and interactive components (e.g. *Blue's Clues*). The negative relationship between viewing *Teletubbies* and vocabulary acquisition can be explained by loose narrative structure and poor language models such as "baby talk" of *Teletubbies*.

Limitations

We began our study at 18 months when the vocabulary spurt begins but were unable to report whether similar results would hold for children under the age of 18 months. The forced-choice method is a good index for children 18 months and older. It would be important to use different methodological approaches, including deferred imitation and habituation measures to examine learning from video under 18 months (for review see Barr, 2008; Christakis, 2009; Courage & Setliff, 2009). It is also possible that vocabulary learning from video may not be enhanced before the vocabulary spurt at approximately 18 months of age (Barr & Wyss, 2008; DeLoache et al., in press; Krcmar et al., 2007), but this requires further empirical investigation.

We were unable to establish the role of the parent in aiding the transfer of learning from 2-D to 3-D context from the present study. The role of parental scaffolding requires additional empirical investigation (see Barr et al., 2008; Deloache et al., in press). It is possible that, in the context of parent–child interactions and video, learning may be facilitated only under certain conditions where the content is outside that which might typically be covered by a parent. That is, the content may prompt enhanced parental engagement around new materials. This remains an important question to be examined in future research.

Conclusions and Implications

The early 1990s saw an explosion of programs and videos designed specifically for infants and toddlers. Though many have expressed concern about the media-saturated nature of young lives today, surprisingly little research has been conducted investigating the developmental impact of video viewing on infants and toddlers. Thus, despite this plethora of new media aimed at the very young, little is known about the extent to which children 2 years and younger (infants and toddlers) learn from commercially produced programs.

The findings from this study indicate that the content (in particular the novel aspect of the information), the presentation style of the content, and the amount of repetition are all important factors to consider when examining learning from video during toddlerhood. This mirrors what we know about the impact of media on older children. The impact of such media is driven largely by content, and children learn specific skills and knowledge from specific televised content (Huston & Wright, 1997; Rice, Huston, Truglio, & Wright, 1990). This study indicates that this may be true among toddlers as well as among older children—at least with respect to word recognition and shape learning of a novel shape. In this study, we found that when given content with a clear educational curricula and simple presentation, toddlers were able to learn from it. Although it is highly likely that infants would exhibit mapping to objects more rapidly after a live demonstration, it is important to note that parents in the control condition did not teach their infants the crescent shape. As books may expand the knowledge base during early childhood, similarly, video producers may be in a position to extend the infant knowledge base. This study adds to a growing body of literature and much-needed information that can be drawn upon by parents, scholars, policy makers, and those concerned with creating entertaining and educational technology for toddlers. Though this study suggests that some learning from video is possible among children under age 2, additional empirical research on the effect of different types of learning strategies and specific content on learning from video is necessary.

REFERENCES

American Academy of Pediatrics. (2001). Children, adolescents and television. *Pediatrics*, *107*, 423–426.

Anderson, D. R., Huston, A. C., Schmitt, K. L., Linebarger, D. L., & Wright, J. C. (2001). Early childhood television viewing and adolescent behavior: The recontact study. *Monographs of the Society for Research in Child Development*, *66*, 37–66.

Anderson, D. R., & Pempek, T. A. (2005). Television and very young children. *The American Behavioral Scientist*, *48*, 505–522.

Barnat, S. B., Klein, P. J., & Meltzoff, A. N. (1996). Deferred imitation across changes in context and object: Memory and generalization in 14-month-olds. *Infant Behavior & Development*, *19*, 241–252.

Barnett, S. M., & Ceci, S. J. (2002). When and where do we apply what we learn? A taxonomy for far transfer. *Psychological Bulletin*, *128*, 612–637.

Barr, R. (2008). Attention to and learning from media during infancy and early childhood. In S. L. Calvert & B. J. Wilson (Eds.), *Blackwell handbook of child development and the media* (pp. 143–165). Malden, MA: Blackwell.

Barr, R., & Hayne, H. (1999). Developmental changes in imitation from television during infancy. *Child Development*, *70*, 1067–1081.

Barr, R., Muentener, P., & Garcia, A. (2007). Age-related changes in deferred imitation from television by 6- to 18-month-olds. *Developmental Science*, *10*, 910–921.

Barr, R., Muentener, P., Garcia, A., Fujimoto, M., & Chavez, V. (2007). The effect of repetition on imitation from television during infancy. *Developmental Psychobiology*, *49*, 196–207.

Barr, R., Somander, M., & Wyss, N. (2009). Imitation from television during infancy: The role of sound effects. *Journal of Experimental Child Psychology*, *123*, 1–16.

Barr, R., & Wyss, N. (2008). Reenactment of televised content by 2-year-olds: Toddlers use language learned from television to solve a difficult imitation problem. *Infant Behavior and Development*, *31*, 696–703.

Barr, R., Zack, E., Garcia, A., & Muentener, P. (2008). Infants' attention and responsiveness to television increases with prior exposure and parental interaction. *Infancy*, *13*, 30–56.

Bickham, D. S., Wright, J. C., & Huston, A. C. (2001). Attention, comprehension, and the educational influences of television. In D. G. Singer & J. L. Singer (Eds.), *Handbook of children and the media* (pp. 47–72). Thousand Oaks, CA: Sage.

Bloom, P., & Markson, L. (2001). Are there principles that apply only to the acquisition of words? A reply to Waxman & Booth. *Cognition*, *78*, 89–90.

Carver, L. J., Meltzoff, A. N., & Dawson, G. (2006). Event-related potential (ERP) indices of infants' recognition of familiar and unfamiliar objects in two and three dimensions. *Developmental Science*, *9*, 51–62.

Christakis, D. A. (2009). The effects of infant media usage: What do we know and what should we learn? *Acta Paediatrica*, *98*, 8–16.

Christakis, D. A., Zimmerman, F. J., DiGiuseppe, D. L., & McCarty, C. A. (2004). Early television exposure and subsequent attentional problems in children. *Pediatrics*, *113*, 708–713.

Courage, M., & Setliff, A. E. (2009). Debating the impact of television and video material on very young children: attention, learning, and the developing brain. *Child Development Perspectives*, *3*, 72–78.

Crawley, A. M., Anderson, D. R., Wilder, A., Williams, M., & Santomero, A. (1999). Effects of repeated exposures to a single episode of the television program *Blue's Clues* on the viewing behaviors and comprehension of preschool children. *Journal of Educational Psychology*, *91*, 630–637.

DeLoache, J. S., Chiong, C., Vanderborght, M., Sherman, K., Islam, N., Troseth, G., et al. (in press). Do babies learn from baby media? *Psychological Science*.

Fenson, L., Pethick, S., Renda, C., Cox, J. L., Dale, P. S., & Reznick, J. S. (2000). Short-form versions of the MacArthur communicative developmental inventories. *Applied Psycholinguistics*, *21*, 95–115.

Fisch, S. M. (2004). Characteristics of effective materials for informal education: A cross-media comparison of television, magazines, and interactive media. In M. Rabinowitz,

F. C. Blumberg, & E. Everson (Eds.), *The impact of media and technology on instruction*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Flynn, E., & Whiten, A. (2008). Imitation of hierarchical structure versus component details of complex actions by 3- and 5-year-olds. *Journal of Experimental Child Psychology*, *101*, 228–240.

Ganea, P. A., Bloom Pickard, M., & DeLoache, J. S. (2008). Transfer between picture books and the real world by very young children. *Journal of Cognition and Development*, *9*, 46–66.

Garrison, M., & Christakis, D. A. (2005). *A teacher in the living room: Educational media for babies, toddlers, and preschoolers*. Menlo Park, CA: Henry J. Kaiser Family Foundation.

Hanna, E., & Meltzoff, A. N. (1993). Peer imitation by toddlers in laboratory, home, and day-care contexts: Implications for social learning and memory. *Developmental Psychology*, *29*, 702–710.

Hartshorn, K., Rovee-Collier, C., Gerhardstein, P., Bhatt, R. S., Klein, P. J., Aaron, F., et al. (1998). Developmental changes in the specificity of memory over the first year of life. *Developmental Psychobiology*, *33*, 61–78.

Hayne, H. (2004). Infant memory development: Implications for childhood amnesia. *Developmental-Review*, *24*, 33–73.

Hayne, H. (2006). Age-related changes in infant memory retrieval: Implications for knowledge acquisition. In Y. Munakata & M. H. Johnson (Eds.), *Processes of brain and cognitive development. Attention and performance XXI* (pp. 209–231). Oxford: Oxford University Press.

Hayne, H., Boniface, J., & Barr, R. (2000). The development of declarative memory in human infants: Age-related changes in deferred imitation. *Behavioral Neuroscience*, *114*, 77–83.

Hayne, H., & Findlay, N. (1995). Contextual control of memory retrieval in infancy: Evidence for associative priming. *Infant Behavior & Development*, *18*, 195–207.

Hayne, H., Herbert, J., & Simcock, G. (2003). Imitation from television by 24- and 30-month-olds. *Developmental Science*, *6*, 254–261.

Hayne, H., MacDonald, S., & Barr, R. (1997). Developmental changes in the specificity of memory over the second year of life. *Infant Behavior & Development*, *20*, 233–245.

Hayne, H., Rovee-Collier, C., & Perris, E. E. (1987). Categorization and memory retrieval in 3-month-olds. *Child Development*, *58*, 750–767.

Herbert, J., & Hayne, H. (2000). Memory retrieval by 18-30-month-olds: Age-related changes in representational flexibility. *Developmental Psychology*, *36*, 473–484.

Hofer, T., Hauf, P., & Aschersleben, G. (2007). Infants' perception of goal-directed actions on video. *British Journal of Developmental Psychology*, *25*, 485–498.

Huston, A. C., & Wright, J. C. (1997). Mass media and children's development. In I. E. Sigel & K. A. Renninger (Eds.), *Handbook of child psychology*, *Vol. 5* (pp. 999–1058). New York: Wiley.

Kirkorian, H. L., Wartella, E., & Anderson, D. R. (2008). Media and young children's learning. *The Future of Children*, *18*, 39–61.

Krcmar, M., Grela, B., & Lin, K. (2007). Can toddlers learn vocabulary from television? An experimental approach. *Media Psychology*, *10*, 41–63.

Linebarger, D. L., & Walker, D. (2005). Infants' and toddlers' television viewing and language outcomes. *The American Behavioral Scientist*, *48*, 624–645.

Mumme, D. L., & Fernald, A. (2003). The infant as onlooker: Learning from emotional reactions observed in a television scenario. *Child Development*, *74*, 221–237.

Obel, C., Henriksen, T. B., Dalsgaard, S., Linnet, K. M., Skajaa, E., Thomsen, P. H., et al. (2004). Does children's watching of television cause attention problems? Retesting the hypothesis in a Danish cohort. *Pediatrics*, *114*, 1372–1373.

Rice, M. L., Huston, A. C., Truglio, R., & Wright, J. (1990). Words from "Sesame Street": Learning vocabulary while viewing. *Developmental Psychology*, *26*, 421–428.

Rideout, V., & Hamel, E. (2006). *The media family: Electronic media in the lives of infants, toddlers, preschoolers, and their parents*. Menlo Park, CA: Kaiser Family Foundation.

Rideout, V. J., Vandewater, E. A., & Wartella, E. A. (2003). *Zero to six: Electronic media in the lives of infants, toddlers and preschoolers*. Menlo Park, CA: Kaiser Family Foundation.

Robb, M. B., Richert, R. A., & Wartella, E. A. (2009). Just a talking book? Word learning from watching baby videos. *British Journal of Developmental Psychology*, *27*, 27–45.

Roseberry, S., Hirsh-Pasek, K., Parish-Morris, J., & Golinkoff, R. M. (2009). Live action: Can young children learn verbs from video? *Child Development*, *80*, 1360–1375.

Schmidt, M. E., & Anderson, D. R. (2006). The impact of television on cognitive development and educational achievement. In N. Pecora, J. P. Murray, & E. A. Wartella (Eds.), *Children and television: Fifty years of research* (pp. 65–84). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Schmidt, M. E., Pempek, T. A., Kirkorian, H. L., Lund, A. F., & Anderson, D. R. (2008). The effects of background television on the toy play behaviors of very young children. *Child Development*, *79*, 1137–1151.

Schmidt, M. E., Rich, M., Rifas-Shiman, S. L., Oken, E., & Taveras, E. M. (2009). Television viewing in infancy and child cognition at 3 years of age in a US cohort. *Pediatrics*, *123*, e370–e375.

Schmidt, M. E., & Vandewater, E. A. (2008). Media and attention, cognition, and school achievement. *Future of Children*, *18*, 63–85.

Schmitt, K., & Anderson, D. R. (2002). Television and reality: Toddlers' use of visual information from video to guide behavior. *Media Psychology*, *4*, 51–76.

Scofield, J., Williams, A., & Behrend, D. A. (2007). Word learning without a speaker. *First Language*, *27*, 297–311.

Suddendorf, T. (2003). Early representational insight: Twenty-four-month-olds can use a photo to find an object in the world. *Child Development*, *74*, 896–904.

Troseth, G. L., Saylor, M. M., & Archer, A. H. (2006). Young children's use of video as a source of socially relevant information. *Child Development*, *77*, 786–799.

Vandewater, E. A., Rideout, V. J., Wartella, E. A., Huang, X., Lee, J. H., & Shim, M. S. (2007). Digital childhood: Electronic media and technology use among infants, toddlers, and preschoolers. *Pediatrics*, *119*, 1006–1015.

Werker, J. F., Cohen, L. B., Lloyd, V. L., Casasola, M., & Stager, C. L. (1998). Acquisition of word-object associations by 14-month-old infants. *Developmental Psychology*, *34*, 1289–1309.

Zack, E., Barr, R., Gerhardstein, P., Dickerson, K., & Meltzoff, A. N. (2009). Infant imitation from television using novel touch-screen technology. *British Journal of Developmental Psychology*, *27*, 13–26.

Zimmerman, F. J., Christakis, D. A., & Meltzoff, A. N. (2007). Associations between media viewing and language development in children under age 2 years. *Journal of Pediatrics*, *151*, 364–368.

Elizabeth A. Vandewater, PhD, is a senior research scientist at RTI International and an adjunct associate professor at the University of Texas at Houston School of Public Health. Her research focuses on the impact of media and technology on children's health and development. She received her PhD in psychology from the University of Michigan and completed a post-doctoral fellowship at the Institute for Social Research. Prior to joining RTI International in 2008, she was an associate professor at the University of Texas at Austin. E-mail: evandewater@rti.org

Rachel F. Barr, PhD, is an associate professor at Georgetown University. She is currently the director of the Georgetown Early Learning Project studying how infants learn from television, computers, or books and how the home environment influences such learning. She received her PhD in developmental psychology from the University of Otago, New Zealand and completed a post-doctoral fellowship at Rutgers University before moving to Georgetown University in 2001 and was a ZERO TO THREE fellow in 2005.

Seoung Eun Park, MA, is a doctoral candidate in Human Development and Family Sciences at the University of Texas at Austin. Her research focuses on the impact of media and technology on developmental outcomes in infants and toddlers.

Sook-Jung Lee, PhD, is an assistant professor at Chung-Ang University in Korea. She received her PhD in Radio-TV-Film from the University of Texas at Austin. Her research focuses on social impact of communication technology, and children's media use in a family context including parental mediation and developmental outcomes.