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Toddlers' word learning and transfer from electronic and print books

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ABSTRACT

Transfer from symbolic media to the real world can be difficult for young children. A sample of 73 toddlers aged 17 to 23 months were read either an electronic book displayed on a touchscreen device or a traditional print book in which a novel object was paired with a novel label. Toddlers in both conditions learned the label within the context of the book. However, only those who read the traditional format book generalized and transferred the label to other contexts. An older group of 28 toddlers aged 24 to 30 months did generalize and transfer from the electronic book. Across ages, those children who primarily used screens to watch prerecorded video at home transferred less from the electronic book than those with more diverse home media experiences.

Introduction

Shared reading has long been a popular activity for parents and young children. Parents report that they begin reading with children when they are around 7 to 9 months of age (Debaryshe, 1993) and the practice of shared reading with infants and toddlers is linked to children's vocabulary growth (Debaryshe, 1993; High, LaGasse, Becker, Ahlgren, & Gardner, 2000; Karrass & Braungart-Rieker, 2005). The advent of technologies such as touchscreens and smartphones has increased the popularity of electronic reading (e-reading). According to a 2014 report by the Joan Ganz Cooney Center, 31% of parents reported that their children aged 2 to 10 years read electronic books (e-books) (Rideout,

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2014). There were no differences in e-book use depending on age; younger children used e-books just as frequently as older children. At that time, an additional 38% of children did not have access to devices on which to read e-content. With the increasing ownership of smartphones and tablets (Anderson, 2015), e-books are becoming available to, and presumably embraced by, even greater numbers of children. In fact, Overdrive, a popular e-book provider for libraries, reported a 30% increase in children's e-book borrowing between the first quarters of 2015 and 2016 (Overdrive, 2016).

Research has found electronic books to be both supportive of (Takacs, Swart, & Bus, 2015; Zucker, Moody, & McKenna, 2009) and detrimental to (Chiong, Ree, Takeuchi, & Erickson, 2012; Krcmar & Cingel, 2014) children's learning. Differences in the way in which electronic stories include and incorporate interactive features have been identified as one likely explanation for the discrepant findings (Bus, Takacs, & Kegel, 2015). However, preschoolers' comprehension of book content differs from print and electronic media even when the content is closely matched across formats and interactive features are excluded (Krcmar & Cingel, 2014). Thus, interactive features do not completely explain medium-related differences in learning.

Another important factor in children's learning from electronic books may be differences in experience. There is evidence that parent–preschooler interactions with electronic and print formats are different. Children may initiate more overall comments in electronic reading contexts (Korat & Or, 2010); however, they may be more communicative about book content when reading in print. The distinction between overall language and interaction around content may be important. For example, a variety of studies have shown that parents engage in more non-content talk, such as talk about manipulating the device, when reading electronic-format books and provide a higher density of content-related comments and questions in traditional-reading formats (Chiong et al., 2012; Korat & Or, 2010; Krcmar & Cingel, 2014; Parish-Morris, Mahajan, Hirsh-Pasek, Golinkoff, & Collins, 2013). When adult–child interactions during reading differ between print and electronic books, it may result in learning differences between the two media.

An additional and untested possibility is that children come to the book-reading situation with different expectations regarding print and electronic contexts. In this study, we extended the current body of research on reading in different formats by addressing whether learning differences occur even when both built-in interactive features and adult–child interactions during reading are matched. We investigated whether screen media are a good venue for learning and transfer of learned information relative to the well-established activity of book reading. For this purpose, we created a picture book that could be copied exactly in both electronic and print contexts so that we could directly compare word learning from screens versus word learning from physical pages. The book was created to take advantage of the way in which children learn words; a novel object with slight variations in shape and color and a novel label were repeated across multiple pages in the book to give children a variety of exemplars for the novel label. The goal of the book (in both formats) was to give children repeated exposure to different exemplars of the novel object to facilitate children's ability to form a category for the labeled object and, thus, to enable generalization and transfer to new real exemplars (Geraghty, Waxman, & Gelman, 2014). In addition, the novel exemplars were paired alongside objects familiar to children so that they could use mutual exclusivity (the assumption that the label would apply to the whole novel object rather than the familiar object; Markman, 1990) to support their mapping of the new label to the novel object. The researcher also directed children's gaze and pointed at the objects during labeling to support children in learning the label (Baldwin, 1993; Grassmann & Tomasello, 2010; Moore, Angelopoulos, & Bennett, 1999).

Research has linked children's vocabulary growth with exposure to picture books during the early years (e.g., Bus, van IJzendoorn, & Pellegrini, 1995; Sénéchal, Pagan, Lever, & Ouellette, 2008), and print picture books have been used in a variety of word learning studies to teach novel labels to children in research contexts (Ganea, Allen, Butler, Carey, & DeLoache, 2009; Ganea, Pickard, & DeLoache, 2008; Horst, Parsons, & Bryan, 2011; Tare, Chiong, Ganea, & DeLoache, 2010; Walker, Walker, & Ganea, 2013). Children as young as 15 months have been shown to learn novel labels from these specially designed picture books after a single reading, and children as young as 18 months also generalized the label to a new real-world exemplar. We do not know whether the same pattern of performance is obtained when children are exposed to electronic picture books. There is reason to expect that dif-

ferences in children's experiences with the symbolic medium (print or electronic format in this case) could create differences in children's transfer from picture books.

In general, transfer of new knowledge from one context to another is more difficult when the learned information is first encountered in a format different from the situation in which the information needs to be applied (Barnett & Ceci, 2002). For example, research has shown that transfer from touchscreens (two-dimensional, 2D) to real objects (three-dimensional, 3D) is more difficult for toddlers than transfer within the same medium (2D–2D or 3D–3D transfer) (Barr, 2013; Kirkorian, Choi, & Pempek, 2016; Moser et al., 2015; Zack, Barr, Gerhardstein, Dickerson, & Meltzoff, 2009). Young children's struggle to transfer across media can make learning from all types of media a challenge because real-world applications necessarily require cross-medium transfer. For example, a giraffe in a book could be a generic representation of giraffes in general rather than a representation of a specific giraffe (Preissler & Carey, 2004), and children would need to understand that information communicated in relation to a generic representation could also be applied to specific instantiations of its category regardless of the format in which it is depicted.

To transfer information taught in a book to new contexts, children also need to understand the dual nature of the book's depictions both as objects in themselves and as symbols (DeLoache, 1989a). A book is composed of pages that can be grasped and flipped, or in the case of electronic touchscreen books images that can be swiped or tapped, but these depictions also represent real-world items. Research on symbolic development in young children has shown that these children often struggle to think of symbolic objects as both objects in themselves and representations of other objects. For example, 2-year-olds have difficulty in using a picture or video to find an object in a room despite being able to point out and label corresponding furniture (Troseth & DeLoache, 1998). The struggle to draw the symbol–referent connection across media has been shown with transfer tasks using traditional picture books as well. Infants as young as 13 months can transfer information from picture books to real-world objects and situations (Ganea et al., 2008; Keates, Graham, & Ganea, 2014). However, increased variation between the depictions in a picture and real-world referents can lead to more difficulty with transfer tasks. Young children struggle to apply a novel label given in the context of a book in a real-world setting, for example, when the objects in the book vary in color from those used at test (Ganea et al., 2009) or when the objects are depicted as line drawings rather than photographs (Ganea et al., 2008).

Difficulty with transfer from symbolic media may also arise from differences in children's experience with a particular medium. Cross-cultural research emphasizes the importance of children's previous experience in their success at symbolic transfer. Cross-cultural research pits industrialized countries with pervasive use of symbols against cultures in which symbolic depictions are seldom encountered until children enter school. In one study, Callaghan and colleagues (2011) showed that 2- to 4-year-olds in Canada were better able to identify a three-dimensional toy after seeing a picture of it than children in remote areas of Peru and India who had relatively lower exposure to symbols (very limited exposure to photographs, books, or graphics on packaged items). In another study, Walker and colleagues (2013) showed that children in a remote village in Tanzania, who had no experience with pictures, were delayed in using information from picture books to refer to real-world objects when compared with U.S. children. Thus, the types of experiences that children typically have with pictures and books influence children's ability to flexibly apply information from these media to real-world objects.

In modern industrialized cultures, children have quite dissimilar experiences across various media. It is likely that specific experiences that children have with a particular medium influence their expectations about how to treat information encountered through that medium. For example, books are generally read and are infrequently used for other purposes. Although children may flip through books on their own, talk about the pictures, "read" them to their dolls, and more, these activities generally mimic the function of books as things that are read. Screens, on the other hand, have a wide variety of functions. Children may watch movies, chat with their grandmothers on Skype, play video games, look at family photos, and engage in a variety of other experiences. Thus, whereas books generally are for "reading," screens are likely experienced less for reading and more for communication and "entertainment."

In addition to functional differences, the language that adults use with the two media is different. When reading traditional books to young children, parents often link the content in the books to children's experiences (DeLoache & de Mendoza, 1987). They also tend to use generic language, for example, referring to *a* frog in a book as a member of the class of frogs rather than *the* frog as they would for a real frog in the yard (Gelman, Chesnick, & Waxman, 2005). This type of talk gives children practice in linking pictured objects with other objects in their category. Children's experiences with traditional screen formats tend to be quite different from those with books. For example, children often use screens to watch videos on their own without discussion linking depicted events to the real world (Barkin et al., 2006). Even when parents co-view, they do not tend to stop videos to discuss depicted objects or events (Strouse, O'Doherty, & Troseth, 2013). Emerging research with electronic picture books shows that when parents read electronic texts with preschoolers, they discuss aspects of controlling the book at the expense of the type of content-rich talk they provide during non-electronic book reading (Chiong et al., 2012; Parish-Morris et al., 2013). Thus, whereas children routinely experience content-related talk that links information to the real world while reading print books, the type of discussion children experience with screen-based media is more varied in content and form.

Differences in children's experiences could create differences in children's transfer of new knowledge. Previous research has shown that explicitly telling children about specific symbol and referent correspondences supports them in transferring across media—from a model room to a real room (DeLoache, 1989b) and from objects displayed on video to real objects (Strouse & Troseth, 2014). Children's experience with connection-drawing talk when reading print books but not electronic books could be expected to support better transfer from print books. The talk typical during traditional book reading could also support future interpretation of books as symbolic because these experiences highlight the symbolic status of the pictures in the book. The reverse has also been shown in that experiences in which the non-symbolic function of an object is highlighted may detract from future symbolic insights (DeLoache, 2000). Thus, if children's experiences with electronic devices are centered on entertainment activities such as playing games on screens and watching movies, and they are not complemented by supportive language and interactions, children's understanding of the medium as symbolic and as a source of information may be affected.

Differential experiences are one reason to suspect that there may be differential learning across media. There may also be properties of each medium itself that result in differential support for learning and transfer. In the current study, we asked whether toddlers learn and transfer differently from touchscreen books than from traditional picture books. We also began to explore whether the types of experiences toddlers have with a medium predicts their likelihood of transfer to the real world.

Method

Participants

Participants were 101 toddlers: 73 toddlers aged 17 to 23 months (mean age = 20.2 months, *SD* = 2.2; 34 girls) and 28 toddlers aged 24 to 30 months (mean age = 26.2 months, *SD* = 1.8; 13 girls) from a large metropolitan area in North America. Participants were recruited through advertisements, local street fairs, and child-care centers. Data from an additional 23 toddlers were not included in the analyses due to unwillingness to participate in the procedure ($n = 19$), preference to communicate in Spanish (parent report, $n = 1$), or failing both trials in the pretest game ($n = 3$). Younger toddlers were assigned to one of four conditions in a 2 (symbolic medium: electronic book or traditional book) by 2 (condition: learning + transfer or transfer only) design with gender balanced across groups. Older toddlers were assigned only to the two electronic book conditions because we expected from previous literature that toddlers would succeed at our traditional book tasks by 18 months of age (Ganea et al., 2008). Sample sizes were chosen a priori to be comparable to previous word learning studies (e.g., Ganea et al., 2009; Walker et al., 2013). Children who participated had no developmental delays and were exposed to English at least 50% of the time.

The final sample was 67.3% White and 21.8% mixed ethnicity as identified by parents. The remaining participants were Asian ($n = 2$), African Canadian ($n = 1$), Hispanic ($n = 1$), Egyptian ($n = 1$), and East

Indian ($n = 1$), with 4 parents not responding. Parents were generally well educated, with a modal response of a 4-year university degree.

Materials

Picture book

Children were read a seven-page picture book by the experimenter, similar to books used in previous research (Ganea et al., 2008, 2009). This book included photographs of two novel objects (a spaghetti measurer and a citrus reamer), pictured four times each, along with photographs of familiar objects (balls and shoes). Familiar objects were not tested but were included to maintain interest as in previous studies (Ganea et al., 2008, 2009; Schafer & Plunkett, 1998; Walker et al., 2013). Each pictured object was a unique instance of its category, with objects varying in color and texture and slightly in shape (Fig. 1). Objects in the same category with only slight variation were used to facilitate children's interpretation of the novel word as a name for an object category rather than a specific object (Namy & Waxman, 1998). On the first six pages, one novel object was paired with one familiar object. The novel object alternated in material and side across pages. The final page included instances of the two novel objects together so that toddlers would have an opportunity to compare the novel objects in the labeling context before proceeding to the test.

There was no text printed in the book. All children were read the same picture book with one of two memorized scripts, which differed only in the order of the utterances. In one script, the first novel object was labeled as the target object with the label "dax" ("Look at the dax! See the dax! I like the dax!") and the second novel object was labeled "this one" ("Look at this one! See this one! I like this one!"); in the other script, the first novel object received the distracter language and the second novel object received the target language. Each familiar object was labeled once (to maintain interest), and each novel object (target and distracter) was labeled three times per page to ensure that balanced attention was given to the two categories of novel objects that would be presented at test.

The electronic picture book was a .pdf version of the printed book and contained no interactive features beyond page turns. This was done so that content was equivalent across media and the role of the medium itself could be isolated. The electronic book was displayed on a Microsoft Surface Pro 2 tablet. Pages were flipped by swiping across the screen. For the traditional book, each page of the .pdf was printed, cut to match the size of the tablet screen, laminated, and bound.

Test objects

Test objects were presented to children in pairs, including one object from the labeled category and one from the unlabeled category. Three sets of test objects were used, composed of the novel objects pictured in the book (Fig. 2A–C). An additional set of novel objects, that differed in color, in texture, and slightly in shape was used for testing generalization of the label (Fig. 2E).

Questionnaires

Parents filled out the MacArthur–Bates Communicative Development Inventory Short Form Level II (Fenson et al., 2000). This measure is composed of a checklist of 100 words for which parents indicated whether their children said each word. Parents of 20-month-olds checked an average of 40.3 words ($SD = 22.2$; percentile $M = 43.0$, $SD = 27.6$), and parents of 26-month-olds checked an average of 63.3 words ($SD = 26.1$; percentile for those in calculable range $M = 47.3$, $SD = 34.7$).

Parents also completed a questionnaire that included demographic information for the families and information about the toddlers' exposure to English, shared picture book reading, electronic books, videos, and other media.

Procedure

Toddlers participated either in our laboratory on campus (80.2%) or in a testing room at their childcare facility (19.8%). Procedures were identical except for the presence of a parent. The experimenter began by warming up with the child by playing on the floor with puzzles or other toys. Once the child was comfortable, he or she was invited by the experimenter to play some games at a table. Most chil-

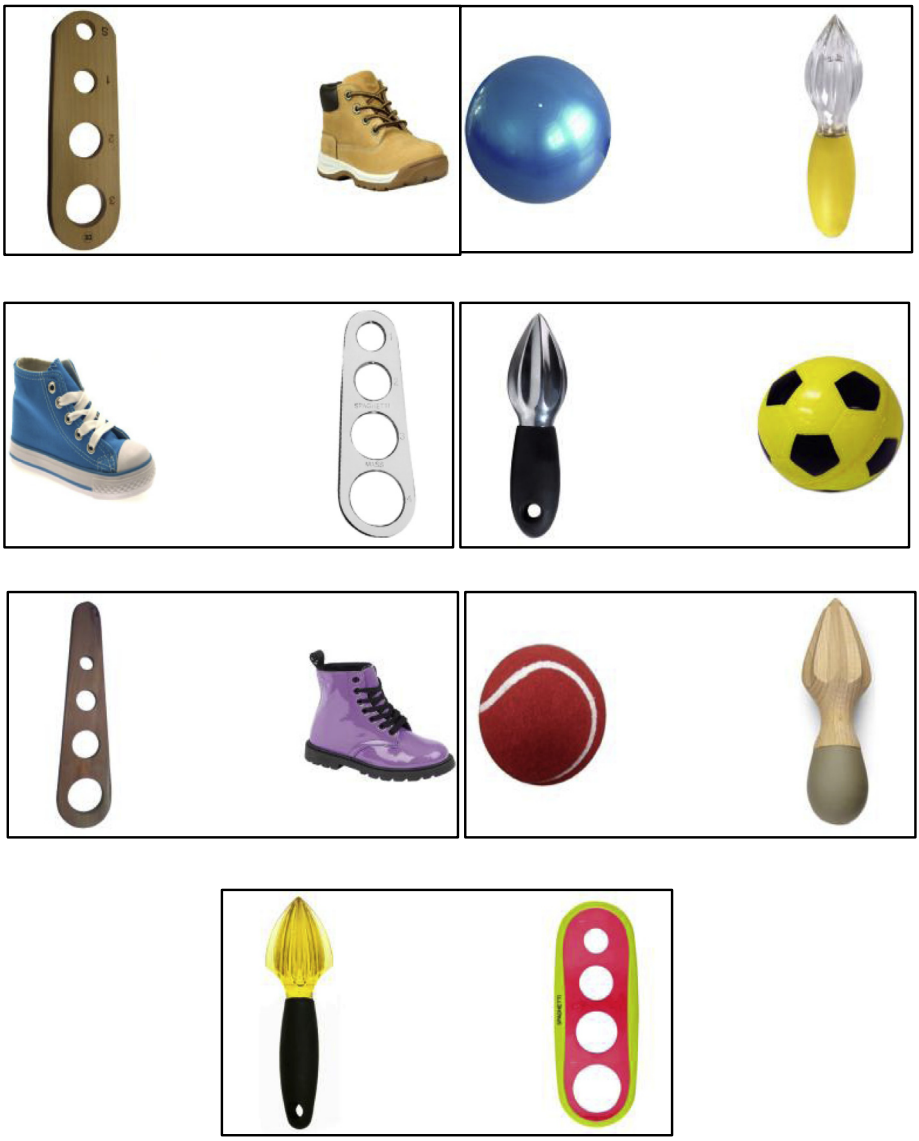

Fig. 1. Picture book pages.

dren sat at a child-sized table across from the experimenter. A few parents at the on-campus testing location opted to hold their children in their lap at the table.

Pretest game

The pretest game was designed to teach children to play the testing game. The toddler was given a few minutes to explore a set of familiar objects (cat, dog, boat, and car) and put them down a slide made of PVC (polyvinyl chloride) pipe. During this time, the experimenter or child labeled each object. Then the experimenter collected the objects and began the game. She held up the first pair of objects, the dog and the car, and asked the child, "I have a dog. Can you show me the dog?" If the child pointed

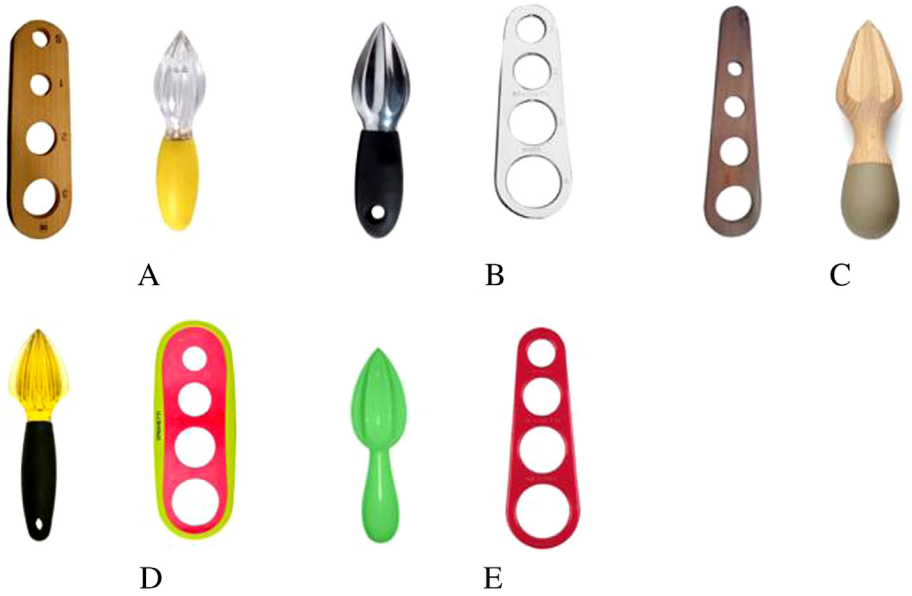

Fig. 2. Novel objects. The objects in Panels A, B, C, and D appeared in the book in the presented order. The objects in Panels A, B, and C were used for testing trained objects with sets counterbalanced across format. The objects in Panel D appeared on the final page of the book and were not used for testing. The objects in Panel E were not seen in the book and were used to test for generalization of the new label.

at or reached for the dog, the experimenter handed the child the dog. Otherwise, the experimenter said "Pick the dog!" and moved the objects closer to the child. If the child chose the dog, the experimenter said "Thank you!" and gave the child the dog to put in the slide. If the child chose both objects, the experimenter pulled them back and prompted, "Just pick one! Pick the dog!" If the child chose the car, the experimenter pulled back and prompted, "That's not the dog! Pick the dog!" This prompt was repeated until the child chose the correct object. Once the child put the target object in the slide, he or she was given the other object to put in. The procedure was then repeated with the other pair of familiar objects, with the requested object on the opposite side. The 3 children who chose incorrectly on both familiar object trials were excluded from analysis for failure to understand the rules of the game.

Book reading

After children learned the testing game, the experimenter moved her chair around the table so she was seated next to the child and began reading the book. In the electronic book conditions, pages were flipped by swiping across the screen. The experimenter demonstrated this motion on the first two pages, and the child was asked whether he or she would like to help flip the remaining book pages. Similarly, in the traditional book conditions, the experimenter flipped the first two pages and then invited the child to participate in flipping the remaining pages. The child was allowed to touch the images in both types of books during reading, but the experimenter maintained control of page flips, allowing them only once she was done reading each page. This involved a similar practice with both types of books—keeping a finger on the top corner of the tablet screen or the top corner of the physical page. During reading, the experimenter pointed at each pictured object as she labeled it. She used child-directed speech and made frequent eye contact with the child. If the child made a comment or asked a question, the experimenter briefly acknowledged this before continuing with the book.

Test game

After reading the book, the experimenter moved her chair so she was again across the table from the child and began the testing games. Children were tested in two conditions. In the *learning + trans-*

Table 1
Question sets asked by condition.

Condition	Question sets asked		
Learning + Transfer	Same medium (trained, generalization)	Real objects (trained, generalization)	Cross-medium (trained, generalization)
Transfer Only	X	Real objects (trained, generalization)	Cross-medium (trained, generalization)

fer condition, toddlers were asked to identify the labeled object within the same medium in which they had read and then to transfer the label to real versions of the novel objects and the other book type. In each tested format, children were asked to identify the labeled object from two sets: a trained set, which they had seen pictured in the book, and a generalization set composed of unseen instances from the category. Thus, in the learning + transfer condition, children completed a total of 6 questions (3 formats $\times$ 2 object sets) (see Table 1).

In the *transfer only* condition, toddlers were not tested in the same-medium trials and were tested only in the two other formats for a total of 4 questions (2 formats $\times$ 2 object sets). This manipulation was included to test whether children could identify the labeled object without being asked the potentially supportive within-medium questions.

The testing game proceeded in a similar fashion to that of the pretest game except that the experimenter did not correct children for incorrect choices. Children were shown a target distracter novel object and asked to "show" or "pick" the dax. Once a child had made a choice (by touching or clearly pointing to an object), the experimenter continued with "Okay!" or "Thank you!" so as not to give evaluative feedback. The order of the trained and generalization trials and the specific object set (see Fig. 2) used for the trained trials were counterbalanced across children.

Coding

Toddlers' familiar and novel object choices were coded as correct if the child selected the requested object first or promptly and spontaneously self-corrected to the requested object. Children's choices were coded as incorrect if the child chose the non-requested object first or promptly and spontaneously self-corrected to the non-requested object. In the case that children chose both objects, their response to a subsequent re-prompt was scored. All novel object choices were coded during the session by the experimenter and also coded from video for reliability by a coder who was blind to the correct answer. Reliability between the coders was kappa = .88, and all disagreements were resolved by a third individual.

Children's attention to the book during reading was coded offline by a coder who reviewed the videotapes and computed a proportion score composed of the total number of seconds the child's eyes were fixated on the book over the total time spent reading. A second person coded 21% of the participants. The interclass correlation for the coders' proportions was .89.

Results

Preliminary analyses indicated no effects of age (within the specified age groups), vocabulary score, percentage exposure to English, attention, or testing location on children's selection of the target object, so these were not included in the subsequent models.

Recognition of the label (same format)

Younger toddlers (20-month-olds)

First, we examined whether toddlers in the learning + transfer condition learned the novel label, as indicated by their ability to recognize one of the trained objects within the same format in which its label was presented. Of 18 toddlers in the younger age group, 17 toddlers (94.4%; 95% confidence interval (CI) [72.7%, 99.9%]) chose the correct item in both the traditional and electronic book groups

(1 child in the traditional book group did not respond to this question). Binomial tests indicated that children in both groups identified the word at above-chance rates ($p < .001$). In a binary logistic regression with the medium in which children read (traditional or electronic book) as the independent variable, there was no effect on toddlers' identification of the trained item, $B = 0.00$, Wald $\chi^2(1) = 0.00$, $p = 1.000$.

Older toddlers (26-month-olds)

All 14 toddlers who were read the electronic book (95% CI [76.8%, 100%]) chose the trained object. This was above the chance rate of .50 ($p < .001$).

Generalization of the label (same format)

Younger toddlers (20-month-olds)

Second, we examined whether toddlers in the learning + transfer group generalized the label to a new exemplar shown again in the same medium in which the label was learned. Of 19 toddlers in the traditional book group, 16 toddlers (84.2%; 95% CI [60.4%, 96.6%]) chose the correct item, which was above the rate of chance ($p = .004$). Of 17 toddlers in the electronic book group, 9 toddlers (52.9%; 1 child did not respond; 95% CI [27.8%, 77.0%]) chose the correct item, which was not above the rate of chance ($p = 1.00$). Toddlers' generalization did differ by medium, $B = -1.56$, Wald $\chi^2(1) = 3.83$, $p = .050$.

Older toddlers (26-month-olds)

All 14 toddlers in the electronic book group (95% CI [76.8%, 100%]) chose the correct object, which was above the rate of chance ($p < .001$).

Transfer of the trained label (across formats)

Next, we examined toddlers' ability to transfer the label they had learned to two other contexts: real three-dimensional versions of the novel objects (real object trials) and across media to the opposite type of book from which they were trained (cross-medium trials). For these trials, there was no difference between toddlers' performance on the trained object set (those seen in the book) and the generalization set (not seen in the book) (as per Wilcoxon signed-rank tests), so performance was collapsed across these two trials and scored out of 2. Because children were tested with pairs of objects, chance performance was a score of 1 out of 2.

Younger toddlers (20-month-olds)

Wilcoxon signed-rank tests against chance (median = 1) revealed that toddlers' performance in the traditional book condition was above chance across all trial sets (real objects and cross-medium pictures for both orders of testing) ($ps \leqslant .007$). On the other hand, children in the electronic book condition did not succeed at above-chance levels on any of the trials ($ps \geqslant .13$). Group performance was also analyzed using a multinomial multilevel model in which each child had a random effect. Scores on the real object set (out of 2) and cross-medium set (out of 2) were set as a repeated measure, and the medium in which children read (traditional vs. electronic) and condition (learning + transfer vs. transfer only) were set as fixed effects. There was a main effect of the medium in which children read, Wald $\chi^2(1) = 6.103$, $p = .013$. There was no effect of trial set (real object or cross-medium), no effect of condition (children who participated in the same-format trials had similar scores as those who did not), and no interaction.

Older toddlers (26-month-olds)

Wilcoxon signed rank tests revealed that children in both conditions (learning + transfer and transfer only) transferred the label to both the real objects and those shown in a different (print) medium at above-chance levels ($ps < .02$). Group performance was also analyzed using a linear mixed model in which each child had a random effect. Scores on the real object set (out of 2) and cross-medium set (out of 2) were set as a repeated measure, and condition (learning + transfer vs. transfer only) was

set as a fixed effect. There was no effect of object set or condition; participation in the same-medium trials did not influence children's transfer.

Experience with media

We asked parents to provide information about children's experiences reading both traditional and electronic books. All parents reported that they read traditional-format books with their children at least once per week. Although many children had access to electronic devices, only 21% of parents reported that their toddlers had ever read an electronic book. Despite a very small sample of only 21 participants, we saw significant differences in the behaviors that parents reported with the two types of media. Parents tended to report many more behaviors that are known to be supportive of vocabulary development when reading traditional-format books (Table 2).

Because only some of these 21 children were spread across the electronic book conditions (others read the print book), we did not have enough power to test relations between parents' reported behaviors with electronic books and toddlers' transfer from the touchscreen book. These differences will be explored further with a larger sample in a forthcoming study. Instead, we opted to test toddlers' experience with electronic books as a binary predictor of transfer success along with an ordinal measure of children's traditional book reading frequency.

We also asked parents to provide information about children's experiences (or lack thereof) with a variety of activities on electronic devices: reading, watching videos, playing games, and interacting via webcam with family and friends (e.g., through Skype). From prior research, we expected that Skype experience would support toddlers' transfer from screens to the real world, whereas more entertainment-based and typically unscaffolded activities such as watching videos would detract from the needed insight (e.g., DeLoache, 2000; Roseberry, Hirsh-Pasek, & Golinkoff, 2014).

We argue that toddlers' most dominant experience with screens, rather than the raw time spent per activity, should be most related to the way in which children conceptualize screens. For example, a child who uses a tablet only to interact for 3 h per week with a grandmother may conceptualize screens as a very contingent real-world experience. However, a child who spends those same 3 h using the webcam but also spends 20 h watching cartoons may think of screens as primarily non-contingent and entertaining. Therefore, we categorized toddlers into five groups based on which activity they most frequently performed with screens: reading, video watching, game playing, communication via webcam, and no clear dominant category. We performed regression analyses using these categories (dummy coded) as predictors for toddlers' transfer from the book to other media (using their total score across the two real object and two cross-medium trials as the outcome variable). Other predictors included book reading frequency (ordinal), experience with electronic books (dichotomous), and age in months. We opted to run separate regressions for toddlers who learned from the traditional

Table 2
Book reading behaviors parents reported as typical for each format of book.

Behaviors reported as typical	Full sample	Sub-sample of parents reporting electronic book use	
	Traditional book ($N = 98$)	Traditional book ($n = 21$)	Electronic book ($n = 21$)
I point to items in the book and label them	88.8	100	66.7*
My child points to items in the book and labels them	86.7	90.5	47.6**
I stop during the reading to discuss the things in the book with my child	73.5	66.7	23.8*
My child "tells" me the story in familiar books	43.9	42.9	14.3*

Note. Values in table are percentages. Asterisks indicate significant differences between traditional and electronic book behaviors reported in just the sub-sample using McNemar's test.

* $p < .05$.

** $p < .01$.

book and from the electronic book so that we could see whether the influence of symbolic experiences was medium specific.

For toddlers in the traditional book groups, the model did not fit well, $R^2 = .37$, $F(6, 24) = 2.37$, $p = .061$. All predictors were non-significant with the exception of frequency of book reading, which positively predicted children's success at the real object and cross-medium trials. However, this model was very underpowered because of the small number of children included in the overall model ($N = 31$) and in some of the sub-groups (as few as $n = 3$). Thus, conclusions could not be drawn from this model. It is included as online supplementary material for the reader's reference.

For toddlers in the electronic book groups, the overall model was significant, $R^2 = .24$, $F(5, 50) = 3.11$, $p = .016$ (Table 3). Age was significantly associated with performance, with older toddlers transferring more frequently. As predicted, having video as a dominant experience was significantly associated with lower scores on the real object and cross-medium trials when compared with children with no clear dominant experience. Having experience with electronic books did not significantly predict children's transfer from the electronic book.

Discussion

This research shows that toddlers generalize and transfer differently from traditional versus touchscreen picture books. Toddlers of all ages learned the trained label for the depicted object regardless of the medium in which they were read. However, 20-month-olds did not successfully generalize or transfer the learned label from the electronic book, using it only in its original context. Toddlers of this same age who were read the traditional book and older toddlers who were read the electronic book did generalize and transfer the label to both real-world and cross-medium exemplars.

These results indicate that at 20 months of age there is a difference in the likelihood that children will transfer information from the screen media format and the traditional picture-book format. This difference does not appear to be developmentally stable given that 26-month-old children learned and transferred from our electronic book. Children's experiences may be an important mechanism for explaining why transfer from the electronic book lagged developmentally behind transfer from the traditional book.

Our results show that the experiences toddlers have with symbolic media are related to their likelihood of transferring information from media to the real world. Toddlers' experiences with traditional and electronic books differed in both frequency and quality, with parents reporting traditional book reading more often and with more scaffolding activities. We have shown that the differences we observed in toddlers' ability to transfer information are predicted by the experiences toddlers have with each medium. Future research should investigate the causal link.

We propose potential causes related to the experiences known to support transfer in other symbolic contexts. For example, explicit scaffolding of the symbol–referent relation is a common aspect of parent–child book reading. Parents often provide labels for items in books, draw connections between book items and those outside the book (e.g., "Frog—You have a frog, a stuffed one"; DeLoache & de Mendoza, 1987, p. 120), and use generics. This type of language may act as direct instruction, emphasizing that items in books are "the same as" items in the real world. Direct instruc-

Table 3
Regression analysis predicting transfer of the label learned from the electronic book.

Predictor	*B*	95% CI		*t*	*p*
Constant	0.58	−1.55	2.71	0.55	.586
Age in months	0.14	0.05	0.22	3.24	.002
Book reading frequency	−0.40	−1.28	0.48	−0.92	.362
Webcam dominant ($n = 10$)	−0.27	−1.20	0.67	−0.57	.572
Video dominant ($n = 30$)	−0.79	−1.52	−0.06	−2.18	.034
Exposure to electronic books	−0.31	−1.07	0.45	−0.82	.417

Note. Model includes data from 56 participants, 16 of whom had no clear dominant screen experience and acted as the reference category. There were no children in the reading or game dominant category.

tion on the symbol–referent link is known to support children in symbolic tasks (DeLoache, 1989b). However, in our sample parents who reported that their children read electronic books reported much less frequent pointing, labeling, and discussion of the items than in traditional books. Thus, children likely have more experience with supportive scaffolding in traditional picture book settings.

Practice also supports children's transfer in symbolic tasks (Marzolf & DeLoache, 1994). Frequent book re-reading experiences allow for practice with familiar examples, possibly supporting children when they encounter new exemplars such as those presented in our picture book. Thus, it is not surprising that book reading frequency predicts children's transfer from the traditional picture book. On the other hand, on the rarer occasion that toddlers are read electronic books, their experiences do not include as much scaffolding, giving them fewer experiences to practice symbol–referent links.

Many of the children in our sample spent a majority of their screen time watching video. These children tended to have *worse* performance on the transfer task compared with toddlers who have more varied experiences with screens. Toddlers with varied experiences had some experiences that may highlight the screen as a symbolic medium (e.g., communicating with a known person not present in the room, watching a video of oneself). These experiences may clue children in to the symbol–referent relation or perhaps give them more insight into the situations in which transfer from the screen is appropriate. Thus, it is not surprising that they were more successful on the real object and cross-medium trials than children who primarily watched pre-recorded videos.

Besides experiences with screens as symbolic, children who experience screens in a variety of ways also may experience screens as contingent devices that respond to their actions. A lack of contingency has been proposed as a reason for infants' struggle to learn language from pre-recorded video presentations (Kuhl, Tsao, & Liu, 2003). Typically, infants and toddlers use cues from adults to disambiguate what is to be learned (Akhtar & Tomasello, 1996; Baldwin, 1995; Tomasello & Barton, 1994). Often these cues are contingent on children's behavior such as calling their name, pointing, or checking to ensure joint gaze. Using these types of contingent cues in closed-circuit video can support learning (Roseberry et al., 2014; Troseth, Saylor, & Archer, 2006). The responsivity of touchscreen apps may also provide support for children's transfer, acting as a pedagogical cue to children that information is relevant and meant for them.

Future research may begin to distinguish whether differences in transfer are related to any inherent difficulty with media or are driven merely by differences in how we culturally treat media. We know that the more interesting an object is in itself, the less likely children are to appreciate its symbolic function (DeLoache, 2000). Touchscreens may be inherently *more* interesting to toddlers than traditional screens because toddlers can control them, possibly making them particularly difficult for children to use symbolically. However, experience likely also plays a large role in the development of children's use of symbolic media.

Educators and researchers are increasingly advocating touchscreen devices as having an educational potential if their design and use are based on well-established evidence-based principles (Hirsh-Pasek et al., 2015). Touchscreens make some features of computers accessible to the very youngest children; they can interact with devices that respond to their actions, are tailorable (respond differently to different children), and are progressive (allow children to pick up where they left off and build in complexity) (Christakis, 2014). Others have suggested that electronic books may be effective because animations and sounds are available to support verbal information (Bus et al., 2015). Given the widespread use of screens around the world (Heggestuen, 2013), it has become crucial that researchers, app developers, teachers, and parents consider the type of experiences that foster children's learning from electronic devices. We have shown here that toddlers' transfer of information from a touchscreen book is delayed compared with their transfer from a traditional book. We have also shown that the types of experience that toddlers have with the medium predict whether they transfer information from it. To promote transfer from touchscreen devices, parents of young children may want to use similar strategies to those used in a picture book reading interaction such as pointing to and labeling images on the screen, drawing children's attention to the correspondence between things in the book and their real-life experience, and providing content that goes beyond what is displayed.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jecp.2016.12.001.

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