AN OPEN BOOK: WHAT AND HOW YOUNG CHILDREN LEARN FROM PICTURE AND STORY BOOKS

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AN OPEN BOOK: WHAT AND HOW YOUNG CHILDREN LEARN FROM PICTURE AND STORY BOOKS

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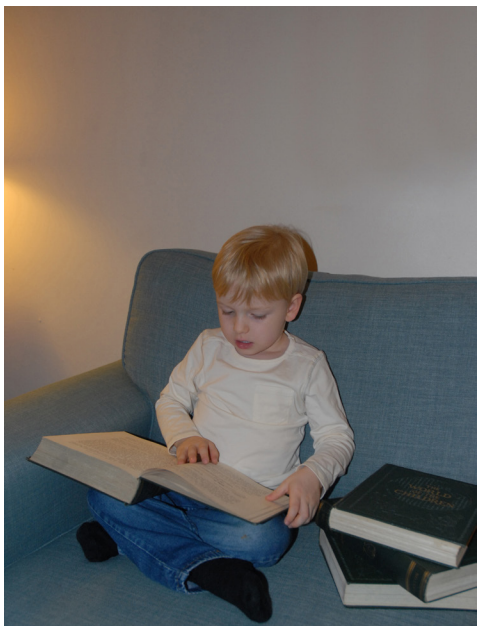

Image by Jessica Horst.

Looking at and listening to picture and story books is a ubiquitous activity, frequently enjoyed by many young children and their parents. Well before children can read for themselves they are able to learn from books. Looking at and listening to books increases children's general knowledge, understanding about the world and promotes language acquisition. This collection of papers demonstrates the breadth of information pre-reading children learn from books and increases our understanding of the social and cognitive mechanisms that support this learning. Our hope is that this Research Topic/eBook will be useful for researchers as well as educational practitioners and parents who are interested in optimizing children's learning.

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EDITORIAL
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Editorial: An Open Book: What and How Young Children Learn from Picture and Story Books

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Keywords: storybook attributes, word learning, stereotypes, anthropomorphism, cross-cultural comparisons

Looking at and listening to picture and story books is a ubiquitous activity, frequently enjoyed by many young children and their parents. Well before children can read for themselves they are able to learn from books. Looking at and listening to books increases children's general knowledge, understanding about the world, and promotes language acquisition. This collection of papers demonstrates the breadth of information pre-reading children learn from books and increases our understanding of the social and cognitive mechanisms that support this learning. Our hope is that this Research Topic/eBook will be useful for researchers as well as educational practitioners and parents who are interested in optimizing children's learning.

We conceptually divide this research topic into four broad sections, which focus on the nature and attributes of picture and story books, what children learn from picture and story books, the interactions children experience during shared reading, and potential applications of research into shared reading, respectively.

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ATTRIBUTES OF PICTURE AND STORY BOOKS

The first section of this research topic focuses on the nature and structural attributes of picture and story books that influence the benefits of shared book reading. Three papers report empirical studies exploring how changes in story book attributes influence adult interaction style and child recall of story content (Greenhoot et al., 2014; Nyhout and O'Neill, 2014; Read, 2014). Greenhoot et al. (2014) examine the effect of storybook illustrations. Specifically, they gave parents either illustrated or non-illustrated stories to read with their 3–4-year-old children. Illustrated stories lead to more verbal and non-verbal exchanges between parents and children during shared reading and better recall of the story events by children. Nyhout and O'Neill (2014) explore the impact of narrative structure on book reading style. Parents read picture books to their 21-month-old children that either included contextual illustrations (narrative) or decontextualized illustrations (non-narrative). Although the two types of books elicited the same number of natural facts about animals overall, mothers reading narrative books provided more story-specific statements about the animals while mothers reading non-narrative books provided more labels and physical descriptions of animals. Finally, Read (2014) examined the effect of rhyme on children's learning of names for novel monsters. Two- to four-year-old children heard stories where either monster names did not rhyme with a descriptive feature, or where the name occurred before the feature (non-predictive rhyme) or after the feature (predictive rhyme). Children identified significantly more monsters by name if the names followed a predictive rhyme. Together, this sub-collection of papers demonstrates the dramatic influence picture and storybook attributes can have on parent reading behavior and children's learning.

The next two papers present cross-cultural comparisons of the messages conveyed by storybooks (Suprawati et al., 2014; Vander Wege et al., 2014). Suprawati et al. (2014) compared the nature of the challenges faced by protagonists in story books published in Indonesia, Japan and the United States, along with how these challenges were resolved. Japanese stories contained the largest number of challenges, and a greater proportion of challenges that were resolved by the protagonist alone compared to American stories. In a similar vein, Vander Wege et al. (2014) coded the illustrations of books published in Romania, Turkey and the United States for the depiction of emotional expressions. As predicted by cultural norms, American books showed more intense emotional reactions—especially negative expressions. These studies reveal that story books reflect (and may also teach children about) the values of one's cultural group.

The final two papers in this section consider the methods used by researchers to establish which features of story books best support learning. Wagner (2013) provides an opinion piece arguing for the need of a quantitative database of the content of children's books. She explains how such a database could be used to support theoretical claims about the content of picture books and to identify testable hypotheses about the features that help children learn to retell stories. A second methodological paper, by Burris and Brown (2014), reviews the external validity of narrative comprehension assessments, drawing particular attention to research with children from low-SES and minority populations. They argue that researchers should test comprehension using real-time, on-line assessments during the story reading (e.g., think-aloud protocols, probe questions), as well as off-line assessments of children's comprehension (e.g., free recall, cued recall and story retelling).

LEARNING FROM PICTURE AND STORY BOOKS

The next section in the series focuses on what children learn from storybooks. Three papers focus specifically on word learning (Houston-Price et al., 2014; Khu et al., 2014; Williams and Horst, 2014) and a further six focus on how shared book reading supports developments in children's understanding of people (Abad and Pruden, 2013; Golos and Moses, 2013), animals (Ganea et al., 2014; Waxman et al., 2014), food (Heath et al., 2014), and even geometry concepts (Flevares and Schiff, 2014). Khu et al. (2014) demonstrate that teaching 21-month-old toddlers the name of a novel object through a picture book facilitates their ability to learn objects' non-obvious properties (e.g., lighting-up with applied pressure; introduced through a second picture book). Houston-Price et al. (2014) found that both 4- and 6-year-olds were able to provide accurate definitions of new words introduced in stories, but that only the older group formed lexical representations that enabled them to make correct grammaticality judgments about these words. By reading stories immediately before nap time, Williams and Horst (2014) were able to explore the added benefit of sleep on word learning from story books in a preschool sample. Together, these papers add to the literature demonstrating that children acquire new vocabulary knowledge through picture and storybooks (see also Read, 2014) and further elucidate the extent and depth of the knowledge gained.

The next two papers present opinions on how story book characters can help change children's stereotypes. First, Abad and Pruden (2013) synthesize what we know about the influence of story books whose characters engage in atypical gender behavior on children's subsequent play. The authors argue that story books provide a practical (and inexpensive) method for influencing gender stereotypes in a positive way. Golos and Moses (2013) take a similar approach to examining children's perceptions of deaf characters. In addition to reviewing how story books can help present the Deaf community positively, Golos and Moses make recommendations about the quality of the story line required if story books are to captivate and engage children.

The next pair of papers examines the effects of anthropomorphism in story books (Ganea et al., 2014; Waxman et al., 2014). In Ganea et al. (2014), 3–5-year-olds were read books with either anthropomorphic or realistic illustrations and either anthropomorphized or factual language. Both anthropomorphic illustrations and language lead to lower levels of learning, especially for the youngest children. In Waxman et al. (2014), 5-year-old children listened to a book about bears before completing a reasoning task. Children who read a book depicting bears scientifically (e.g., Animal Encyclopedia) generalized properties from one animal to another in the reasoning task (a biological perspective), while those who read a book depicting bears anthropomorphically (e.g., The Berenstain Bears) did not. Note, the stories used by Nyhout and O'Neill (2014) and Greenhoot et al. (2014) also included animals.

The final pair of papers in this section branch out to explore how story books can be used to change children's perceptions of food and mathematics (Heath et al., 2014). Heath et al. (2014) report that looking at picture books about an unfamiliar vegetable with toddlers encourages them to eat the vegetable when it is later offered at a mealtime. The effect was largest for foods that were unfamiliar to children before they saw the books. Heath et al. suggest that picture books might help more broadly to familiarize children with situations that they might otherwise reject. Flevares and Schiff (2014) undertake a chronological review of the evolution of different perspectives on the role of books in supporting school-aged children's learning of mathematical concepts, such as plane geometry. They explore the benefits of using picture-based literature for children's learning of and motivation to engage with mathematics concepts, and for the training of teachers in the delivery of these concepts.

INTERACTIONS BETWEEN READERS AND READING MATERIAL

The third section in the series focuses on how children and parents interact with the story and each other during shared reading situations. Two papers in this section focus on the reading behaviors of middle-class African American (Harris and Rothlein, 2014) and Japanese (Murase, 2014) mothers. Harris and Rothlein (2014) found large individual differences in

mothers' reading styles. However, the most common narrative-eliciting strategies included questions about the characters and refocusing statements (e.g., directing the child to look back at the illustration). Murase's (2014) 7-month longitudinal study of maternal reading behavior found that mothers initially focus on providing information to children and that they display more requests for information over time. The number of information-seeking requests by mothers was positively correlated with children's productive vocabularies. In the next paper, Kucirkova (2013) reviews how children interact with iPad books, which she suggests offer a useful tool for examining how children engage with stories. Kucirkova also highlights the need for researchers to acknowledge the learning opportunities provided by children's increasing experiences with digital media.

INTERVENTIONS USING STORY BOOKS

The final section of the series takes a more applied angle. Two papers (Adlof et al., 2014; Tsunemi et al., 2014) present preliminary data from interventions using story books that show promise in helping children improve key skills. Adlof et al. (2014) confirmed the feasibility of a new intervention for low-SES children: structured narrative retell instruction (SNRI). In a group intervention, clinicians asked children questions about each component of the narrative (e.g., the characters) after each reading. Children who completed the intervention showed improvements in narrative macrostructure (including the total number and diversity of the words they used and their mean length of utterance) and overall vocabulary scores. Tsunemi et al.'s (2014) intervention aimed to help school-aged children with autism improve their social perspective-taking skills. Parents read narrative books to their children for almost a week and asked questions about the mental states of the characters after each reading. Children in the intervention group improved in their ability to take second- and third-person perspectives in a social perspective-taking task. Together, this pair of feasibility studies suggests that narrative storybooks provide a suitable medium for a range of interventions to support children's development.

CONCLUSIONS

The goal of this Research Topic was to foster an interdisciplinary exchange of the methods that have been used to uncover how and what young children learn from books and the knowledge that this work has revealed. The final collection of articles has exceeded our expectations in regard to its breadth of offering, including work by researchers from fields comprising communication science, education, linguistics, psychology and speech and language disorders. The volume provides an eclectic but complementary overview of the current state of research on the status of picture and story books in young children's development. Our reading of this literature is that books are a powerful and somewhat unharnessed resource that could be employed to a much greater extent to help children to engage with and make sense of the world around them.

AUTHOR CONTRIBUTION

Both JH and CH wrote the editorial and determined the groups of articles into the four categories presented in the editorial.

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ORIGINAL RESEARCH ARTICLE
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More than pretty pictures? How illustrations affect parent-child story reading and children's story recall

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Previous research showed that story illustrations fail to enhance young preschoolers' memories when they accompany a pre-recorded story (e.g., Greenhoot and Semb, 2008). In this study we tested whether young children might benefit from illustrations in a more interactive story-reading context. For instance, illustrations might influence parent-child reading interactions, and thus children's story comprehension and recall. Twenty-six 3.5- to 4.5-year-olds and their primary caregivers were randomly assigned to an Illustrated or Non-Illustrated story-reading condition, and parents were instructed to "read or tell the story" as they normally would read with their child. Children recalled the story after a distracter and again after 1 week. Analyses of the story-reading interactions showed that the illustrations prompted more interactive story reading and more parent and child behaviors known to predict improved literacy outcomes. Furthermore, in the first memory interview, children in the Illustrated condition recalled more story events than those in the Non-Illustrated condition. Story reading measures predicted recall, but did not completely account for picture effects. These results suggest that illustrations enhance young preschoolers' story recall in an interactive story reading context, perhaps because the joint attention established in this context supports children's processing of the illustrations.

Keywords: children's memory, parent-child story reading, illustrations, preschoolers, story recall

INTRODUCTION

A glance at the early childhood sections of any library or bookstore reveals that pictures books, or books in which pictures complement or dominate the text (Jalongo, 2004), are quite common in young children's literature. Why are illustrations so ubiquitous in story books for young children? It is widely believed that story illustrations help capture children's attention to stories and facilitate their understanding and retention of what is being read to them. This conclusion is bolstered by studies of preschool children's visual attention during storybook reading, which shows that they are overwhelmingly focused on the illustrations rather than the print (e.g., Evans and Saint-Aubin, 2005; Justice et al., 2008). Although pictures may capture children's attention, research from our laboratory and others suggests that they may not actually enhance very young children's comprehension and recall of the stories they accompany, at least in controlled story presentation contexts (e.g., Greenhoot and Semb, 2008). It remains to be seen, however, whether illustrations have different effects on children's processing of stories when they are read in a more naturalistic and interactive story-reading context. Therefore, we designed this experiment to examine the effects of story illustrations on parent-child story reading and preschool children's story recall. Because our work is grounded in the literature on memory and narrative development, we focused on children's abilities to recall the major events that took place in the story, rather than other dimensions such as vocabulary or a moral.

It is well-established that, among school-aged children and adults, memory for prose that is presented in written or auditory form is enhanced by illustrations (Levin and Lesgold, 1978; Brookshire et al., 2002; Carney and Levin, 2002). There are a number of explanations for this picture-enhancement effect. Exposure to information both verbally and pictorially may result in the construction of memory representations in both modalities that then provide redundant retrieval routes (Paivio, 1986, 1970). Pictures may also enhance attention and comprehension or organization of material, or provide cues about important information in the text to keep activated, all which may promote the formation of stronger, more elaborated and more organized memory traces (Gernsbacher, 1990; Levin and Mayer, 1993).

Although picture-facilitation effects are well-established in the literature on school-aged children and adults, the developmental literature suggests that story illustrations might not yield the same benefits for very young children as have been observed for older children (e.g., Guttman et al., 1977; Furnham et al., 2002; Pike et al., 2010). A few studies have documented picture-enhancement effects in preschoolers but only for very specific auditory information (e.g., the object of a sentence) that is also explicitly depicted in the pictures (Pressley et al., 1982; Digdon et al., 1985). This line of work has also shown that younger children require greater redundancy between the pictures and auditory information to show mnemonic benefits than do older children (Guttman et al., 1977; Furnham et al., 2002).

Research from our own laboratory on children's memories for more complex story narratives found that illustrations failed to enhance the memories of young preschoolers when they accompanied prerecorded stories (Greenhoot and Semb, 2008). In that study, children who were between 46 and 63 months of age were exposed to a story about a fictional animal character in one of four story-presentation formats: the verbal story narrative with illustrations, the narrative alone, the narrative with uninformative illustrations, or the illustrations alone. To ensure that the verbal presentation was identical across groups, the story narrative was pre-recorded and a tone cued children to turn the page. Although children in all verbal groups accurately recalled more story events than those in the picture-only group, for children younger than 4.5 years, there were no differences in recall performance between the three verbal groups. With increasing age, children exposed to the illustrated story narrative increasingly outperformed those in the other verbal groups, such that children older than 4.5 years did benefit from the informative illustrations. These benefits, moreover, were limited to information presented both in the text and the pictures. The overall pattern of results suggested that the illustrations did not simply improve motivation and attention to the listening task. Rather, the children must have attended to the content of the pictures because it determined whether they were effective in facilitating recall.

One explanation for the younger children's failure to benefit from story illustrations is that they may not understand the relevance of illustrations and therefore fail to encode the illustrations or use them as retrieval cues (e.g., Pressley and MacFadyen, 1983). Indeed, in the handful of studies that observed picture facilitation effects for preschoolers' recall of simple stimuli, the children were warned of the memory test and explicitly prompted to attend to the pictures (Pressley et al., 1982; Digdon et al., 1985). Another possibility is that very young children lack the processing capacity necessary to attend to and encode both the story and the pictures and to connect them in memory (Dempster, 1981; Cowan et al., 2002). Consistent with this argument, Mayer and Moreno (1998) showed that adults' ability to combine auditory and visual details in memory depends on the availability of working memory resources. Finally, the literature on symbolic development would suggest that young children struggle to maintain and connect the visual and verbal representations of the story in memory (e.g., Flavell et al., 1986; DeLoache, 2000).

In any case, it seems possible that illustrations could yield benefits in a story reading context in which an adult supports or "scaffolds" children's attention to and understanding of the illustrations. When a parent or other adult reads a story to a child, both the child and the reader may ask questions and make comments about the pictures and text. Research on adult-child story reading suggests that these types of story-reading behaviors enhance children's processing of stories. For example, adult references to print, both verbal and non-verbal, increase preschoolers' references to print (e.g., Justice et al., 2002, 2008). Moreover, parents' attempts to actively engage young children during story reading (Kang et al., 2009), and children's spontaneous utterances to parents (Kim et al., 2011), predict better child story retelling. These types of behaviors during parent-child story-reading also predict children's long-term literacy outcomes, including vocabulary and story comprehension skills (e.g., Whitehurst et al., 1988; Haden et al., 1996; Reese and Cox, 1999; Hood et al., 2008). Although no studies have examined the specific role of illustrations in influencing parent-child story reading interactions, it seems quite possible that illustrations might elicit more discussion than narrative alone, which in turn might enhance children's comprehension and recall of the story. Thus, although illustrations alone might not enhance young children's memories for stories in a controlled story presentation context, illustrations could yield benefits in an interactive story-reading context.

Therefore, we designed this study to examine the specific role of illustrations in influencing parent-child storybook reading behavior and eliciting parent and the effects on 3.5 to 4.5-year-old children's story comprehension and recall. Children in this age range did not benefit from illustrations when they accompanied audio-recorded stories in Greenhoot and Semb (2008). In the current study we tested whether they would benefit when the same story narratives and pictures were used in an interactive story-reading context. We asked parents to read either an illustrated or non-illustrated story to their children, and later asked the children to retell the story to an experimenter. We analyzed the qualities of the story reading interactions in these two conditions and examined the relations to children's story recall. The specific aims were to (a) assess the influence of story illustrations on parent and child story-reading behavior, (b) examine the effects of illustrations on young preschoolers story recall in this interactive story-reading context, and (c) to determine how group and individual differences in parent-child story-reading behavior relate to preschoolers' recall of illustrated and non-illustrated stories.

METHODS

PARTICIPANTS

The participants were 26 preschoolers ($M = 48$ months, range = 38–58 months) and their primary (or co-primary) caregivers from a small city in the Midwestern United States. Participants were volunteers who were recruited through ads distributed through local preschools, posted in the public library, and published in local newsletters aimed at families. Fifty-eight percent of the children were female. Almost all (92%) of the dyads were Caucasian, 4% were Hispanic and the remaining did not specify the parent or child's ethnicity. The mean level of education of the participants' parents was 16.8 years (range = 13–18 years) for mothers and 15.8 years (range = 7–18 years) for fathers, indicating that the children were generally from college-educated, middle-class families. Responses to a background questionnaire administered at the beginning of the study indicated that none of the child participants knew how to read at the time of the study. One parent-child dyad was unable to schedule the second session within a reasonable time frame, making the sample size for the 1-week recall analyses 25 rather than 26.

PROCEDURE

The participants met individually with the experimenter for two sessions. To make participant recruitment easier, parents were given the choice of scheduling both sessions in a university laboratory space or in their homes; about half of the

participants chose to meet in their homes (for both sessions) instead of the laboratory space, and this variable was relatively evenly distributed across story-reading conditions (39% in the Illustrated condition and 54% in the Non-Illustrated condition, $X^2_{(1)} = 0.62$, $p = 0.43$). Dyads were randomly assigned to the Illustrated (I) or Non-Illustrated (NI) story-reading condition. The stories and the illustrations were the same as those used in two conditions of our previous study, and were experimentor-designed rather than commercially available books (Greenhoot and Semb, 2008). The Illustrated and Non-Illustrated book versions described the same 18 events involving a fictional animal character; in the Illustrated books, the gist of each event was depicted in two colorful illustrations. The main events of the story described actions of the fictional animal, as described below. Parents were encouraged to "read or tell the story" in the same manner in which they normally read stories to their child.

After the parent finished reading the story to his or her child, he or she completed a demographic questionnaire while the child completed a puzzle as a distracter task (approximately 5 min). This activity was followed by a Memory Interview in which the experimenter asked the child to recall the story. Approximately 1 week later ($M = 7$ days, range = 5–9 days) the same experimenter again met with the dyad and administered a second Memory Interview to elicit the children's delayed recall of the story. We videotaped the story-reading interactions and the memory interviews for later analysis. All procedures in this study were approved by the university Human Subjects Committee.

MATERIALS

Stories

As in the previous study, we used two different stories within each story presentation group to ensure that any effects were not specific to a particular set of stimuli. Within each story presentation group participants were randomly assigned to either the "Basil the Bobbin" story or the "Wilbur the Woozle" story, each of which were constructed for use in this (and other) research in our laboratory. Each story began with a brief description of the characteristics of a fictional type of animal (e.g., woozles have smooth skin, long snouts, fat bellies that they slide around on, and live in hollow logs) and then described a series of 18 events involving a specific animal character. An event was defined as a self-contained set of actions or occurrences that revolve around a central character, time, or place that have independent coherence (Linton, 1986); for these stories, each event was broadly defined by a place or time period in the story. Each event first described the setting for the event and initiating actions (e.g., Wilbur the Woozle sees a beautiful, shiny rock in a hole, but cannot get it out with his paw), and then described response actions and resolution of the event (e.g., Wilbur uses his long snout to push the rock out of the hole). The event narratives in the Bobbin story averaged 6.7 sentences, and 64.7 words, each, whereas those for the Woozle story averaged 6.6 sentences and 61.9 words.

In the Illustrated condition, there were two pictures per event, illustrating the gist of each event component (i.e., the setting/initiating actions and the resolution). For example, for the shiny rock event in the Woozle story, the first illustration depicted Wilbur looking at a shiny rock in a hole. The second illustration showed Wilbur with his snout extended to the hole to push it out.

Memory Interview

The Memory Interview consisted of a series of open-ended questions about the story at two levels of specificity. The interview began with a very general question (e.g., "What happened in that story about Wilbur the Woozles search for a new home?") to which children were encouraged to provide as much information as possible. This general probe was followed by more focused open-ended questions about each story event not already recalled by the child (e.g., "What happened when Wilbur saw the shiny rock?"). Children were prompted to elaborate on each event with, "Can you tell me more about that?" or "How did that happen?" All children were interviewed by the same experimenter for both sessions.

CODING

Story-reading interactions

Drawing on previous research on parent-child story reading, we coded the videotaped story-reading interactions for a number of qualities, which are summarized in **Table 1**. First, we coded the frequency of several types of parent and child extra-textual comments and non-verbal behaviors during reading. All comments were divided into propositions (subject-verb constructions), with each unique or non-redundant proposition scored as a comment. We categorized these comments and behaviors according to their relation to the book content, including direct references to the book and/or the pictures or text in the book, references to the events described or depicted in the book, and elaborations on story content. We also coded for child inattentiveness by identifying the number of story events during which the child was inattentive to the story, and counted the number of parent attempts to redirect children's attention to the story reading task. We also scored the interactions on several global qualities. First, raters made a yes-no judgment about whether the story-reading activity was highly "interactive," defined as involving susbtantial verbal and/or non-verbal exchange between parent and child. They also made yes-no judgments about whether the parent was engaged in the story-reading task, and yes-no judgments about whether the child was largely distracted throughout the story-reading session. Finally, they rated parent emotional expressiveness on a 0–2 scale, with a 0 being no emotion expressed, a 1 being occasional or intermittent displays of emotion, and a 2 being consistent expression of emotion. All coding was completed by two raters. Interrater reliability, calculated on approximately 20% of the videotaped interactions, was high, with the raters agreeing on 93% of the scores they assigned. In addition to the interaction coding, the raters measured the length of time parents and children took to read each book.

Story recall coding

Children's recall performance was evaluated for accuracy and completeness by comparing their reports in the memory interviews to the actual text of the stories. Each story event that the child reported was assigned one of four codes: Accurate Complete, Elaboration, Partial Recall, or Distortion. If the child

Table 1 | Story-reading interaction codes.

Type of code	Coding category	Description	Scoring
Specific comments and behaviors	Parent or child book-directed behaviors	Pointing to book content (text or pictures), labeling, describing or otherwise discussing pictures or words presented in the book (e.g., "What is he doing now?")	Frequency
	Parent or child event-related comments	Comments or questions directly related to the story events, such as inferences about causality (e.g., "He must have been hungry") or predictions about what will happen (e.g., "Now he's going to get breakfast")	Frequency
	Parent or child elaborations	Comments or questions that involved relating the story to pre-existing knowledge (e.g., "What other animals eat bugs?"), to one's own life (e.g., "Grandpa's name is Wilbur, too"), or evaluative remarks (e.g., "Flies are yucky.")	Frequency
	Child inattention	Indicators that the child is not attending to the story	Number of story events
	Parent redirections	Parent comments intended to redirect the child's attention to the story	Frequency
Global qualities	Interactive story-reading	Substantial verbal and/or non-verbal exchange between parent and child	0 = no 1 = yes
	Child distraction	Child highly disengaged; no attempts to interact with parent about the story and does not respond to parent attempts	0 = no 1 = yes
	Parent engagement	Parent is engaged in story reading task, makes consistent attempts to go beyond text-reading and respond to child attempts	0 = no 1 = yes
	Parent expressiveness	Degree of parent emotional expressiveness during story reading	0 = none 1 = intermittent 2 = consistent

recalled the gist of what was stated in the text about an event, the response was coded as Accurate Recall (e.g., "Wilbur got the rock out of the hole with his snout."). Accurate Recall also included embellishments on the text that were generally consistent with the text (e.g., "Wilbur dug and dug with his snout until he finally knocked the rock out of the hole."). If a child only recalled part of an event (i.e., if the child did not report the event resolution) but was otherwise accurate, the event was assigned a Partial Recall code (e.g., "Wilbur could not get the rock out with his foot."). A Total Recall score was calculated as the sum of Accurate Recall and Partial Recall. A Distortion was coded when a child distorted a story event in recall (e.g., "Wilbur ate the rock."), whereas an Intrusion was coded when a child reported an event that was not described in the text at all (e.g., "Wilbur rode a bicycle."). Two research assistants each scored the interview transcripts, overlapping on approximately 20% of the sample for reliability purposes. Interrater reliability for the memory codes was quite good, as indicated by percent agreement of 94%.

For each child at each interview, we calculated a Total Recall score as the proportion of story events receiving an Accurate Complete, Elaboration, or Partial Recall code. We also calculated a more conservative recall score of Accurate Complete Recall, consisting of the proportion Accurate Complete and Elaboration codes. Finally, we calculated Recall Error scores as the proportion of story events for which children received Distortion or Intrusion scores.

RESULTS

We designed the analyses to address each of the three major aims of the study. First, we examined group differences in parent and child story-reading codes, to determine whether the illustrations affected the quality of parent-child storybook reading. Next, we tested the effects of the illustrations on children's story recall. Third, we explored how individual differences in parent-child story reading interactions related to children's story recall in the two presentation conditions.

PARENT-CHILD STORY-READING BEHAVIOR

Preliminary analyses indicated that parent comments, summed across the individual story reading codes, were quite frequent

($M = 22.5$) and more than twice as common as comments from the child ($M = 10.8$). Individual parent story-reading codes were interrelated; parent book-related comments were positively associated with parent event-related comments and parent redirections ($rs \geq 0.48$, $ps \geq 0.01$), and parent elaborations were correlated with parent event-related comments and parent emotion expressiveness ($rs \geq 0.65$, $ps \leq 0.0003$). Child story reading codes were also interrelated, with child event-related comments positively associated with book-related comments and elaborations ($rs \geq 0.61$, $ps \leq 0.0009$). Finally, parent and child measures also correlated with each other, with particularly strong associations between parent and child codes for the same types of comments ($rs \geq 0.57$, $ps \leq 0.002$).

There were several indications that the illustrations affected parent-child story-reading interactions. As shown in **Table 2**, both parents and children made more direct references to the book and more comments about the text in the Illustrated than Non-Illustrated condition. In contrast, illustrations did not produce significant differences in the frequency with which parents or children made comments about the story events or elaborated on story content. Furthermore, although parents tended to do more redirecting and children were inattentive more frequently in the Non-Illustrated condition, these differences did not reach significance. Interestingly, parent emotion expressiveness scores were higher in the Non-Illustrated condition than the Illustrated condition.

Figure 1 summarizes the global story reading interaction scores for the two conditions. Almost two-thirds of reading sessions in the Illustrated condition were coded as Interactive story-reading, compared to 31% in the Non-Illustrated condition, although the difference did not reach significance, $X^2_{(1)} = 2.48$, $p = 0.12$. Although parent engagement was unaffected by Illustration condition, children in the Non-Illustrated condition were significantly more likely to be distracted from story reading than those in the Illustrated condition, $X^2_{(1)} = 4.89$, $p = 0.027$. Indeed, of the 7 children rated as highly distracted, 6 were in the Non-Illustrated condition. Further, 4 of these children (all Non-Illustrated) had parents who made many attempts at redirection or engagement (i.e., between 19 and 60 parent comments and gestures across the story reading session).

There was no significant difference between conditions in the length of the reading sessions, $t_{(24)} = 0.58$, $p = 0.57$. Book reading took an average of 9 min 18 s in the Illustrated condition, and 9 min 48 s in the Non-Illustrated condition.

Table 2 | Mean scores (and standard deviations) of parent and child story-reading codes, by condition.

	Illustrated condition	Non-illustrated condition	$t_{(24)}$	*p*-value
PARENT BEHAVIORS				
Book-directed behaviors	12.4 (16.2)	2.5 (45)	2.13	0.044
Event-related comments	8.8 (8.9)	8.6 (9.0)	0.07	0.94
Elaborations	4.6 (6.0)	7.1 (8.3)	−1.16	0.26
Parent redirections	1.2 (2.3)	0.5 (0.5)	1.19	0.25
Parent emotional expressiveness	0.85 (0.69)	1.54 (0.52)	−2.89	0.008
CHILD BEHAVIORS				
Book-directed behaviors	5.3 (6.9)	0.8 (2.3)	2.26	0.033
Event-related comments	7.0 (7.9)	4.7 (5.3)	−0.88	0.39
Elaborations	1.7 (1.7)	1.6 (1.7)	0.58	0.57
Inattention	3.9 (3.2)	6.5 (6.9)	−1.21	0.24

ILLUSTRATIONS AND CHILDREN'S STORY RECALL

Figure 2 shows the Total Recall, Accurate Complete, and Recall Error scores for the immediate interview, as a function of story presentation condition. **Figure 3** shows a parallel set of scores for the 1-week interview. Even according to the more liberal scoring scheme used for calculating Total Recall, the children remembered less than half of the events depicted in the story at both interviews. Furthermore, a little over one fourth of the story events were recalled incorrectly at both interviews. Thus, this recall task seemed to be a challenging one for the participants.

Importantly, however, children's story recall was notably better in the Illustrated condition than the Non-Illustrated condition. Specifically, children in the Illustrated condition had higher Total Recall scores than those in the Non-Illustrated condition at the immediate interview, $t_{(24)} = 2.14$, $p = 0.043$. Although Accurate Complete Recall was also higher in the Illustrated condition at the first interview (38% vs. 26%), this difference did not reach significance, $t_{(24)} = 1.52$, $p = 0.14$. The advantage in Total Recall for the Illustrated condition over the Non-Illustrated condition was somewhat maintained at Time 2 (44% vs. 41%), but the difference was no longer statistically significant. Recall Error scores did not differ between story presentation groups at either interview. Thus, in contrast to our previous findings with prerecorded stories in the same age group, illustrations in parent-presented stories

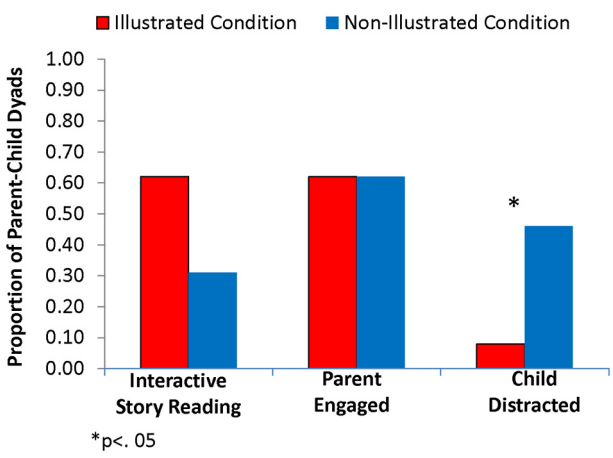

FIGURE 1 | Proportion of parent-child story-reading sessions scored as Interactive, Parent Engaged, and Child Distracted, by condition.

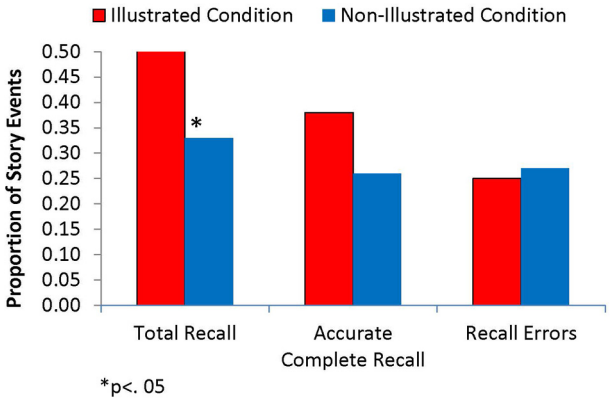

FIGURE 2 | Recall performance at the immediate interview, by story-reading condition.

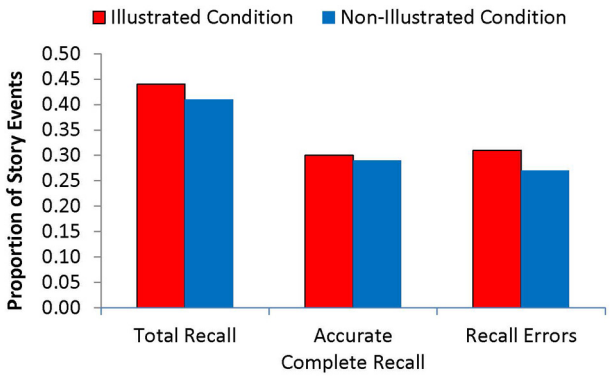

FIGURE 3 | Recall performance at the 1-week interview, by story-reading condition.

increased children's abilities to remember the story narrative, particularly in the short term.

INDIVIDUAL DIFFERENCES IN PARENT-CHILD STORY READING AND CHILDREN'S STORY RECALL

The goal of these anlayses was to examine how the qualities of parent-child story reading predicted children's abilities to retell the story later. We were also interested in whether the qualities of parent-child story reading could explain the modest improvements in recall performance produced by the story illustrations.

Identifying covariates

First, to identify possible covariates to be included in our individual difference analyses, we used pearson correlations, *t*-tests and chi-square analyses to test whether the variables of interest (story reading measures and story recall measures) were associated with variables such as the children's age (in months), gender, and reading experience, mother's years of education, material set, and experiment location (lab vs. home). None of the story reading measures were associated with any of these variables. Children's story recall was related to their age and the location of their experimental sessions. Specifically, older children had higher Accurate Complete Recall and Total Recall scores at both interviews ($rs \geq 0.42$, $ps \leq 0.031$), and lower Recall Error scores at both interviews ($rs \leq -0.38$, $ps \leq 0.06$), although the association with 1-week Recall Errors was only marginally significant. Children who participated in a lab setting had superior story recall to those who participated in their homes, $ts > 2.79$, $ps < 0.01$. For instance, Total Recall scores at the immediate interview averaged 0.52 in the lab condition and 0.30 in the home condition. Story recall was unrelated to child gender, material set, or mothers' education. Therefore, we controlled for both session location (lab = 1; home = 0) and child age (in months) in these analyses.

Predictive models

We tested the relations between story-reading qualities and story recall in a series of general linear models (GLMs) predicting each of the recall measures (Total Recall, Accurate Complete Recall, and Recall Errors) at the immediate and 1-week interview. This approach enabled us to control for age and location and to test each parent story reading code along with the corresponding child code(s). We ran the GLMs separately for memory measures at the two different time points because a traditional repeated measures approach would have resulted in casewise deletion of data from the child who did not participate in the second memory interview.

To test whether the story-reading qualities explained group differences in recall, we first ran a set of models containing only location, age, and group (Model 1). By comparing the parameter estimates for group in this simple model to those in models containing story-reading variables, we could assess the degree to which the story-reading qualities accounted for group recall differences. The small sample size limited the number of predictors we could include in any one model, therefore we tested several sets of models, each with a different category of story reading codes as additional predictors (see **Table 3**). The second set of models (Model 2) tested the predictive value of parent and child event-related comments, over and above group, age, and location. Likewise, the set of models labeled Model 3 tested the predictive values of child inattention and parent redirection when group, age and location were in the model. Finally, model 4 tested the predictive value of the global story reading qualities (i.e., parent emotion expressiveness, parent engagement, child distraction, and interactive story reading). The models with the categories of book-related comments and elaborations as predictors revealed no links between these variables and story recall, therefore we do not present them here.

Table 3 displays the parameter estimates (and standard errors) generated by the GLMs. In Model 1, participation in the lab setting and child age were all positively related to measures of children's recall performance. Furthermore, being in the Illustrated group was related to better Total Recall at the first interview, although this effect was only marginally significant. But the results from Models 2 through 4 provide some evidence that extra-textual comments and behaviors during story reading contribute to children's story recall, over and above the effects of the Model 1 variables. The GLMs testing parent and child event related comments showed that parent comments (Model 2) were

Table 3 | Parameter estimates (and standard errors) generated by GLMs predicting recall performance from child age, experiment location, group, and parent-child story reading codes.

	Immediate interview			1-week interview		
	Total recall	**Accurate complete**	**Recall errors**	**Total recall**	**Accurate complete**	**Recall errors**
MODEL SET 1						
Group (Illustrated)	**0.13[b] (0.09)**	0.08 (0.07)	0.03 (0.08)	−0.028 (0.063)	−0.053 (0.063)	0.09 (0.08)
Age	0.01 (007)	0.012 (0.007)	**0.017* (0.007)**	**0.012[b] (0.006)**	**0.020** (0.006)**	**0.014[b] (0.008)**
Lab	**0.17[b] (0.08)**	**0.17[b] (0.08)**	0.027 (0.08)	**0.30*** (0.07)**	**0.20** (0.066)**	−0.07 (0.09)
MODEL SET 2						
Group (Illustrated)	**0.15[b] (0.07)**	0.10 (0.08)	0.021 (0.08)	−0.038 (0.07)	−0.053 (0.067)	0.09 (0.09)
Age	**0.012** (0.007)**	**0.014** (0.006)**	**−0.016** (0.007)**	**0.012[a] (0.006)**	**0.021** (0.006)**	−0.013 (0.008)
Lab	**0.15[b] (0.08)**	**15[b] (0.07)**	0.013 (0.084)	**0.28*** (0.07)**	**0.18 ** (0.07)**	−0.088 (0.096)
Parent event-related	**0.013* (0.007)**	**0.015** (0.006)**	0.008 (0.007)	−0.000 (0.006)	0.005 (0.006)	0.004 (0.008)
Child event-related	−0.009 (0.009)	−0.011 (0.009)	−0.005 (0.010)	0.004 (0.008)	−0.001 (0.008)	−0.001 (0.01)
MODEL SET 3						
Group (Illustrated)	0.10 (0.084)	0.035 (0.078)	0.06 (0.077)	−0.09 (0.071)	−0.035 (0.069)	0.09 (0.093)
Age	0.009 (0.008)	0.012 (0.008)	−0.011 (0.007)	**0.02* (0.007)**	0.01 (0.007)	−0.008 (0.009)
Lab	**0.17[b] (0.089)**	**0.16[a] (0.083)**	−0.037 (0.082)	**0.20* (0.074)**	**0.32* (0.073)**	−0.13 (0.097)
Parent redirects	0.023 (0.026)	0.035 (0.024)	−0.11 (0.024)	0.03 (0.022)	−0.005 (0.021)	0.02 (0.028)
Child inattention	−0.005 (0.009)	−0.006 (0.008)	**0.018* (0.008)**	−0.005 (0.007)	−0.005 (0.007)	0.01 (0.009)
MODEL SET 4						
Group (Illustrated)	0.11 (0.11)	0.038 (0.10)	−0.14 (0.11)	0.004 (0.081)	−0.018 (0.086)	−0.05 (0.11)
Age	0.004 (0.01)	0.007 (0.009)	**−0.02* (0.009)**	**0.014[a]** (0.007)	**0.024* (0.007)**	−0.013 (0.010)
Lab	**0.21* (0.08)**	**0.20* (0.078)**	0.03 (0.083)	**0.31* (0.063)**	**0.20* (0.066)**	−0.10 (0.089)
Parent emotion exp.	0.004 (0.076)	0.017 (0.072)	**−0.16* (0.076)**	**0.12[b] (0.062)**	0.11 (0.066)	**−0.17[b] (0.088)**
Parent engagement	0.24 (0.15)	0.017 (0.14)	0.006 (0.15)	−0.11 (0.11)	−0.06 (0.12)	0.008 (0.16)
Child distraction	**−0.28[a] (0.14)**	**−0.26[a] (0.13)**	−0.06 (0.14)	−0.03 (0.10)	−0.008 (0.11)	0.06 (0.15)
Interactive story reading	−0.24 (0.17)	−0.14 (0.16)	0.10 (0.17)	0.07 (0.13)	0.08 (0.13)	0.22 (0.18)

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$; $^{a}p < 0.07$; $^{b}p < 0.10$.

related to both Total Recall and Accurate Complete Recall at the immediate interview. The more parents discussed the events in the book with their children, the better children remembered the story events after a short distracter. Importantly, however, parent event-related comments do not appear to explain the advantage in Total Recall of the Illustrated group, as the parameter estimate for group was not reduced by the inclusion of event-related comments in Model 2.

The models including child inattention and parent redirects (Model 3) revealed that child inattention predicted more Recall Errors at the first interview. Therefore, the more story events for which children were not attentive, the more errors they made in retelling the story. Finally, the models that included the global qualities (Model 4) showed that higher parent expressiveness predicted fewer recall errors at the immediate interview and recall of more story events at the delayed interview. Additionally, children who were completely disengaged during story reading had lower levels of Total Recall and Accurate Complete Recall at the immediate interview. Interestingly, in this last set of models the parameter estimate for group was somewhat reduced, suggesting that increased rates of child disengagement in the Non-Illustrated condition could be at least partially responsible for the recall advantage seen in the Illustrated condition.

DISCUSSION

Illustrations are commonplace in storybooks for young children, yet the scant research on their influence on children's story retelling has suggested that young preschool children actually learn very little from story illustrations when they are presented in a non-interactive story-reading context (e.g., Greenhoot and Semb, 2008). The results of this investigation suggest that illustrations do enhance young preschoolers' story recall when they are presented in an interactive story reading context. Thus, young preschoolers may be unable to glean both visual and auditory information from a story and/or integrate the information in a context that requires them to do this alone, but our current findings are consistent with the view that parents help support or "scaffold" such processes in an interactive story reading context. Parents may use the pictures to keep children engaged in the reading activity, help children see the relevance of the illustrations for comprehending the story, and/or facilitate children's ability to attend to the pictures and verbal information and integrate them in memory. These findings fit well with sociocultural models of development, which highlight the role of adult-child interaction in guiding and supporting children's participation in activities and socializing their skill development (Vygotsky, 1978; Rogoff, 1990; Nelson and Fivush, 2004). It should be noted, however that the parent-supported enhancements observed in this study were

not especially robust or long-lasting; pictures facilitated children's immediate recall of the stories but significant benefits were not maintained after a 1-week delay.

Our analyses of the story reading interactions reveals some of the things parents might do to support children's processing of the illustrations. These analyses showed that the presence of illustrations influenced both parent and child behaviors during story reading. Both parents and children made more references to the book in the Illustrated condition, and this increase in book references was not limited to the illustrations themselves. Parents and children also made more references to the text when pictures were present than when they were not. Nonetheless, the predictive models showed that these references to the book were not directly related to children's recall of the story events.

The global measures of story reading quality also indicated that the illustrations prompted a more interactive and engaged style of story reading. Children in the Illustrated condition were less likely to be rated as distracted than those in the Non-Illustrated condition. Indeed, of the 7 children who were rated as distracted, 6 were in the Non-Illustrated condition and 4, all of whom were in the Non-Illustrated condition, had parents who had made numerous engagement attempts. Thus, these parent efforts at engagement may have failed without the support of pictures. The predictive models showed that children who more frequently displayed inattentiveness, and those who were judged to be completely distracted during the story presentation, had poorer recall performance at the immediate interview. Moreover, the predictive value of group was somewhat reduced when these attention variables were included in the models. These patterns suggest that the parents may have used the illustrations to hold children's attention to the story reading activity, leading to improved recall of the story events, at least in the short-term.

Interestingly, parent emotional expressiveness was actually higher in the Non-Illustrated condition than the Illustrated condition, suggesting that parents may have tried to compensate for the absence of illustrations by increasing their emotional expressiveness as they read. Perhaps they were using this elevated emotional expressiveness to keep children engaged with the story reading activity. Thus, our small sample of well-educated mothers appears to be quite sensitive to the story reading context. The fact that parent emotion expressiveness also was related to fewer recall errors at both interviews and higher overall recall at the 1-week interview recall suggests that compensation attempts for the absence of pictures could have reduced the robustness of the differences between the Illustrated and Non-Illustrated conditions. Of course, within-person comparisons of maternal story reading with illustrated and non-illustrated stories would provide a more definitive evaluation of this claim. It also remains to be seen whether this pattern would generalize to a more diverse sample, as pre-emergent reading behaviors have been shown to vary according to socioeconomic status (Bus et al., 1995). It would also be important to explore whether these illustration effects on parent expressiveness would generalize to different types of stories (e.g., stories that are either more or less interesting than those used here).

References to the events described in the story were the one category of story-reading measures that did not differ across the Illustrated and Non-Illustrated groups. However, consistent with the literature on parent-child story-reading interactions (e.g., Kang et al., 2009; Kim et al., 2011), individual differences in this dimension of story reading interactions were linked to differences in children's recall at the initial interview. In particular, children whose mothers offered more comments and questions about the events described in the stories, such as inferences or predictions about what will happen, learned more from the stories than other children. Therefore, although this feature of the interactions did not seem to account for the illustration effects, it seemed to support children's recall of the events in the story regardless of the presentation format.

Overall, the pattern of results in this study suggests that the illustrations prompted more interactive story reading and more behaviors known to predict improved literacy outcomes for children (e.g., Whitehurst et al., 1988; Haden et al., 1996; Reese and Cox, 1999; Hood et al., 2008). Furthermore, the illustrations did produce recall enhancements and parent and child story-reading behaviors predicted children's story recall. Nonetheless, our story reading measures only partially accounted for the effects of the illustrations on children's story recall. This pattern suggests that our story reading measures simply may not have captured the actual mediating variables. For instance, it seems likely that it is simply the joint attention established between parent and child in this context supports children's processing of the illustrations. It is also quite possible that the dimensions of story-reading that we measured support dimensions of children's processing and recall of the stories that we did not capture in this study.

The current study was limited to mother-child story storybook reading, and there is some evidence that parent-child book-reading may differ for mothers and fathers (Anderson et al., 2004). For instance, Anderson et al. (2004) found that fathers asked for more clarification and made more confirmations when reading informational books to their 4 year-olds than mothers. Although previous research has not found differences in how fathers and mothers read narrative stories to children, future research should explore whether the effects of illustrations observed in mothers in this study extend to fathers' reading styles.

Another future consideration in understanding illustration effects on book reading with young children is the genre of book, as some work has documented differences in book reading interactions depending on genre of book (Mason et al., 1989; Price et al., 2009). Price et al. (2009) found substantial differences in parents' book reading, for storybooks verses informational, nonfiction books. For instance, parents spent more time reading and commenting on the informational books than the storybooks. Moreover, parents provided more feedback to the child, commented more about the character/animal, and made more elaborations and inferences during the informational book reading. Interestingly, the storybooks in their study averaged eight more illustrations than the informational books. Similar interactional patterns have been observed with teacher book sharing (Mason et al., 1989). Parents' and teachers' heightened commenting and elaborating on informational books could potentially provide even greater scaffolding for illustration processing, leading to heightened picture facilitation effects.

These findings have a number of implications for understanding the optimal ways of presenting stories to young children, and address issues that are particularly important in an age of increasing reliance on non-human sources of information for children. First, this study highlights the fact that a story presentation context that allows for social exchange may be critical for helping children to process and retain narratives or other material from storybooks. Second, for young preschoolers in the prereading phase, story illustrations help to elicit the sorts of story-reading interactions that are known to enhance children's story processing and relate to positive literacy outcomes. One necessary extension of this line of work is to examine how digital technology affects shared book reading. Some work suggests that children adopt a more participatory role when read an e-book by a researcher than a traditional storybook (Moody et al., 2010). Yet other work suggests that touch sensitive e-readers may negatively impact parent-child shared book reading interactions and children's comprehension (Parish-Morris et al., 2013). With the proliferation of e-readers for people of all ages, it is time to find out whether such media can provide as supportive an environment for adult-child story-sharing interactions as a traditional illustrated storybook.

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Storybooks aren't just for fun: narrative and non-narrative picture books foster equal amounts of generic language during mother-toddler book sharing

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Parents and children encounter a variety of animals and objects in the early picture books they share, but little is known about how the context in which these entities are presented influences talk about them. The present study investigated how the presence or absence of a visual narrative context influences mothers' tendency to refer to animals as individual characters or as members of a kind when sharing picture books with their toddlers (mean age 21.3 months). Mother-child dyads shared both a narrative and a non-narrative book, each featuring six animals and matched in terms of length and quantity of text. Mothers made more specific (individual-referring) statements about animals in the narrative books, whereas they provided more labels for animals in the non-narrative books. But, of most interest, the frequency and proportion of mothers' use of generic (kind-referring) utterances did not differ across the two different types of books. Further coding of the content of the utterances revealed that mothers provided more story-specific descriptions of states and actions of the animals when sharing narrative books and more physical descriptions of animals when sharing non-narrative books. However, the two books did not differ in terms of their elicitation of natural facts about the animals. Overall, although the two types of books encouraged different types of talk from mothers, they stimulated generic language and talk about natural facts to an equal degree. Implications for learning from picture storybooks and book genre selection in classrooms and home reading are discussed.

Keywords: generic language, parent-child interactions, book sharing, narrative books, informational books, book genre, contextual influences

INTRODUCTION

Individuals possess knowledge about events, objects, and living things that they have not observed first hand. Historical events, entities too distant, and those too minute, are beyond what the average human can observe. Yet, most of us possess at least some basic information about the ice age, the planet Jupiter, and atoms. Given that most individuals will never have the opportunity to participate in an archeological dig or peer through an electron microscope, we must learn about such entities indirectly. Two important sources of this information for children, relevant to the present article, are the testimony of other individuals (Harris and Koenig, 2006) and picture books (DeTemple and Snow, 2003).

As children encounter objects (e.g., a bicycle) and animals (e.g., an elephant) in picture books and other settings, they may take them to be individuals (e.g., Jamie's bicycle; Babar) or members of a category (e.g., bicycles; elephants) (Hall et al., 2001). When referring to entities in the world, certain linguistic markers can distinguish whether one is communicating about the entity as an individual or as a member of a category. Information that is conveyed using specific language tends to refer to individuals (e.g., "Shadow has a soft coat"), whereas information that is conveyed using generic language pertains to categories (e.g., "Dogs have four legs"). Information that is delivered using generic language is readily incorporated into children's knowledge-bases (Prasada, 2000; Cimpian and Markman, 2008). This can lead to robust learning of facts about the world (e.g., elephants are very social animals) that is resistant to counter-examples (e.g., Rowan the elephant isn't sociable). Thus, whether children consider an entity as an individual or as a member of a category can influence whether they incorporate the information they encounter into their knowledge-base. As such, it is of interest to investigate the factors that influence whether talk about entities is primarily individual-referring vs. category-referring.

CONTEXTUAL INFLUENCES ON GENERIC LANGUAGE USE

In a study by Gelman et al. (2005), parent-child conversations included more generic utterances when dyads interacted with pictures of objects than when they interacted with the objects themselves. Gelman and colleagues suggested this was because pictures are more representational of categories, whereas objects are more likely to be perceived as individuals in their own right. Comparing parent-toddler conversations across picture book sharing and toy play, Gelman and Tardif (1998) similarly found that generic utterances were more common during picture book sharing than during toy play, comprising 4.7% of utterances during book sharing. Thus, it is clear that contextual factors influence the use of generic, category-referring language during interactions between parents and their preschoolers or toddlers. In subsequent studies,

Gelman et al. (2013) found that adults and 5- and 6-year-olds used more generics when they were in a pedagogical context or role than when they were in a "peer-to-peer" situation. These findings provide support for Csibra and Gergely's (2009) theory of natural pedagogy, which posits that pedagogical contexts encourage the communication of generic information.

Given that picture book sharing seems to be a particularly fruitful setting for talk about categories, it is of interest whether the format in which animals are presented in books can influence the use of language referring to individuals and categories. Recently, in a first study to investigate this, Gelman et al. (2013) analyzed 75 informational and narrative picture books designed for 4- to 9-year-olds and found that informational books contained significantly more generic noun phrases than narrative books. Both types of books, however, contained significantly more specific noun phrases than they did generics.

Together, these studies established that context does indeed influence the extent to which entities are considered as individuals or as members of a category, as reflected by the relative frequency of generic language use. Moreover, two of these studies (Gelman and Tardif, 1998; Gelman et al., 2005) demonstrated that generic language is present in mothers' talk with their toddlers (25- to 38-month-olds and 19- to 23-month-olds, respectively), the population relevant to the present study (18- to 25-month-olds).

Given the young age of the children in the present study, another important consideration is the extent to which children of this age are sensitive to cues in language that distinguish generic and specific referents. Gelman and Raman (2003) found that 2-year-olds were sensitive to relevant morphosyntactic cues, such as the presence or absence of the definite article, *the* (e.g., "Do the birds fly?" vs. "Do birds fly?"). Graham et al. (2011) found that 30-month-olds, but not 24-month-olds were able to distinguish between generic and non-generic utterances to make inferences about novel kinds. However, because this task required the extra step of inductive inference, the findings do not necessarily indicate a lack of comprehension amongst the younger age group. Although there is currently no evidence that children are able to distinguish between such syntactic cues before the age of two, the presence of such syntactic distinctions in the input from adults certainly precedes their understanding.

THE EFFECT OF BOOK GENRE

As mentioned above, picture book sharing appears to stimulate generic language use more than other types of parent-child interactions that have been studied. How parents' generic language use may vary as a function of book genre has not, to our knowledge, been a subject of previous investigation. In particular, because the educational value of storybooks has been called into question (e.g., Torr and Clugston, 1999; Bosman, 2010), it is of interest to investigate the extent to which different types of books for young children encourage parents to express generic knowledge and facts.

Recent media reports suggest that picture storybook sales have declined as parents seek books that they believe are more educational (e.g., Bosman, 2010), such as early readers and informational books. Non-narrative books (e.g., books focusing on building vocabulary) for children frequently make claims about the types of skills and knowledge they can provide, whereas storybooks tend to provide only short synopses. Whether the nature of the communicative interaction that arises is indeed more 'educational' when sharing non-narrative books, compared to narrative books, is relatively unstudied (Nyhout and O'Neill, 2013). Because of documented cross-contextual differences in parents' talk, it is of interest to investigate how the genre of book parents share with their children may affect their use of more "educational" or "pedagogical" talk. Although pedagogical contexts certainly encourage many types of language, our focus in the present study was specifically on two types of language as indices of *pedagogical language*: (1) generic language and (2) natural facts.

Most investigations of the influence of book genre have compared parents' abstract comments and questions during narrative and informational (i.e., non-fiction) book sharing interactions between parents and *preschoolers*. Generally, these studies have found that mothers' talk is more abstract during informational book sharing than during narrative book sharing (Torr and Clugston, 1999; DeTemple, 2001; Anderson et al., 2004; Price et al., 2009).

In contrast to findings with preschoolers, we found that mothers' talk with *toddlers* was more complex during narrative book sharing than during non-narrative book sharing (Nyhout and O'Neill, 2013). This different pattern of results was likely due to differences in the age of the children and the fact that we employed greater experimental control over the books being compared. Previous studies comparing narrative and informational books used books that differed on a number of dimensions such as subject, number of pages, and quantity of text (Torr and Clugston, 1999; DeTemple, 2001; Anderson et al., 2004).

In addition to this sizable body of work investigating differences in parents' talk across book genres, in one study (Ganea et al., 2011) it was also noted that children were able to generalize a principle (camouflage) learned from a picture book to real world problems. They were able to do this regardless of whether the information was presented in a factual or intentional (i.e., narrative) framework, although the specific focus of the study was not on book genre.

RATIONALE FOR THE PRESENT STUDY

In the present study, we analyzed the interactions from Nyhout and O'Neill (2013), but in this case were interested in whether the context in which an animal was presented in a picture book influenced the extent to which mothers referred to the animal as an individual or as a member of a kind. We were specifically interested in whether the *presence or absence of narrative context* influenced mothers' tendency to refer to the characters as individuals or as members of a kind.

Suppose that a book features 6 animals. One prediction might be that presenting the 6 animals in the framework of a narrative will lead parents and children to consider the animals as *individuals* (e.g., The Bear). Indeed, it is often the intention of tellers of narratives to introduce the audience to individuals; the presence of characters is at the core of what it is to be a narrative (Bruner, 1986). In contrast, if the 6 animals are presented in a contextless (i.e., non-narrative) manner typical of didactic books, parents and children may be more likely to think about

and discuss *categories or kinds* of animals (e.g., bears). Indeed, introducing the audience to categories of animals or objects is often the goal of creators of non-narrative books (Martin, 1985). In support of these views, the content analysis of the texts of children's narrative and informational picture books by Gelman et al. (2013), discussed above, did find that the texts in informational books contained significantly more generic noun phrases than the texts of narrative books.

But in book sharing interactions between parents and children, parents' talk may be differentially influenced by book genre. This may especially be the case in parent-toddler interactions, given that books with little to no text may be shared, and parents are freer to talk about the content as they wish, as found in Nyhout and O'Neill (2013). Thus, with respect to the use of generic or non-generic language, it is not necessarily the case that differences found to exist within the *texts* of different genres of books will pertain in the same manner to parents' *talk* when sharing these different genres of books with their child. Indeed, in a broader context, the syntactic constructions presented in picture books texts for 2-year-olds have been found to significantly differ from those occurring in parents' talk with children aged 21–32 months (Cameron-Faulkner and Noble, 2013). It is an open question whether findings on genre differences in book texts extend to parents' talk, especially when sharing books with very young children, who are the focus of interest in our present study.

Thus, to explore the influence of book genre on talk about individuals and kinds, we compared mothers' talk with their toddlers while they shared two picture books, each about 6 animals: a short narrative and a non-narrative book. In the narrative books, the animals were introduced one-by-one within the context of a story with background scenes and with no text except for the label of each animal when first introduced. In the non-narrative books, the animals were introduced one-by-one alone on a blank page with a single label (see Methods). Thus, the key manipulation was the presence or absence of a narrative context.

We were interested in both the *framing* and the *content* of mothers' utterances. In coding the framing, we looked at whether mother's statements were presented with a *generic* (e.g., "*Lions* say "roar"") or *specific* subject (e.g., "*He* says "roar""), or as a label (e.g., "That's a lion"), based on the coding scheme developed by Gelman et al. (2005). In coding the content, we looked at whether mothers' utterances comprised a *physical description* of an animal in the book (e.g., "He has black and white fur"); a *story-specific* description of an animal's state or action (e.g., "The bear is sleepy"), or a *natural fact*, which included a description of an unobservable behavior or property of an animal in the book (e.g., "He (badger) uses his sharp claws and goes dig, dig, dig"). Note that these two levels of coding (framing and content) can offer unique information, especially when the content concerns physical descriptions or natural facts. For example, a *natural fact* could be presented by a mother using generic (e.g., "Armadillos can curl up in balls") or specific syntax (e.g., "He can curl up in a ball").

It seems reasonable to expect that mothers will employ more specific utterances during narrative book sharing; that is, as the animals engage in actions unique to the story, it is likely mothers will describe these actions (e.g., "The elephant is escaping from the cage!"). However, the differences across narrative and non-narrative genres in generic language use are harder to predict, if differences are present at all. On the one hand, one may predict that the non-narrative books will elicit more generic language from mothers, because the animals in the non-narrative books may be seen as more representational of categories than when they are presented in the framework of a narrative. Note that this prediction would be in line with the predictions and findings of Gelman et al. (Gelman and Tardif, 1998; Gelman et al., 2005). On the other hand, one may predict that the narrative books will elicit more generic language from mothers, because the context provided by the narrative books may trigger generic knowledge about the animals. For example, reading the popular children's book *Stellaluna* may remind parents of facts about bats' diet, habitat, and behaviors in ways that a picture of a bat may not. Thus, we did not have firm predictions about how narrative context would influence mothers' use of generic language, though we expected more specific language during narrative book sharing.

METHODS

PARTICIPANTS

Twenty-five mother-toddler dyads participated in the study (12 girls, mean child age = 21.3 months, range = 18.9 to 25.4 months). Two additional dyads participated but were dropped because they failed to complete one of the books ($n = 1$) and because the child was distracted for most of the book sharing interaction ($n = 1$). Participants were recruited from a university laboratory database of local families and through advertisements in the community. Fifteen mothers (63%) had completed an undergraduate degree or higher, eight had completed a technical college diploma (33%), and two had completed a high school diploma (8%). Mothers ranged in age from 25 to 39 (mean = 32.6 years). Dyads were screened for prior exposure to the two books used in the study at the time of recruitment.

MATERIALS AND DESIGN

The books for the study were created by adapting two commercially-available children's picture books, *Good Night, Gorilla* (Rathmann, 1994) and *Don't Wake Up the Bear!* (Murray, 2003). In *Good Night, Gorilla*, a zoo keeper makes his rounds to ensure all the animals are locked away for the night. Unbeknownst to the zoo keeper, a gorilla has stolen his keys and sneaks behind him as he walks through the zoo and unlocks the other animals' cages. In turn, an elephant, a lion, a giraffe, a hyena, and an armadillo all escape. The animals then follow the zoo keeper back to his house. In *Don't Wake Up the Bear!*, we are introduced to a bear sleeping in his cave in a snowy forest. Five other woodland animals, who are out in the cold, are trying to find a warm place to sleep. One-by-one, a hare, a badger, a fox, a squirrel, and a mouse come by until they are all cuddled up together in the bear's cave. Both original stories continue, but we ended the adapted versions at the points described to allow for consistent length across book versions (described below). Both books contained six animals in total and began with a single animal that was joined by a new animal on each page, until all six were together.

From each original book, we created one narrative and one non-narrative version for our study, which were matched for

length in terms of both number of pages and amount of text, and the target content of interest (i.e., the six animals). *Good Night, Gorilla* and *Don't Wake Up the Bear!* were renamed *Animals at the Zoo* and *Animals in the Woods*, respectively. The narrative versions of each book included the same original illustrations, but the text on each page was removed and replaced with a single label per page identifying the focal animal. For the non-narrative versions of each book, we cropped the focal animal from each page in the original and placed it in the center of a blank page with the same single label. Thus, the two versions of each book included the same text (the label for each animal) and the same focal animal. Critically, the illustration of the animal was the same across both genres. The manipulation of interest was therefore the presence or absence of an illustrated narrative context. For both the narrative and non-narrative versions of each book, the final page presented all animals together with no text. The narrative versions included the original illustrations, whereas the non-narrative versions included discrete illustrations of each animal that were arranged in a line across the page. Readers interested in seeing the two versions of the books may contact the authors for a copy.

Our design was within-subjects, and dyads shared either the narrative version of *Animals at the Zoo* and the non-narrative version of *Animals in the Woods*, or the narrative version of *Animals in the Woods* and the non-narrative version of *Animals at the Zoo*. The order of presentation was fully counterbalanced.

PROCEDURE

Dyads were presented with the first book and were asked to share the book as they would at home. The second book was placed in a box, outside the child's view, and mothers were asked to retrieve it after finishing the first book. They were asked to share each book only once, from front to back. Dyads sat with the child on the mother's lap, in separate chairs beside each other, or on the floor together. The interactions were video recorded.

TRANSCRIPT CODING

The interactions were transcribed using the Codes for the Human Analysis of Transcriptions (CHAT) transcription system (MacWhinney and Snow, 1990; MacWhinney, 2000). Because each dyad shared two books (one narrative and one non-narrative), there were two transcripts per dyad.

To begin with, all utterances in the transcripts that referred to one of the six animals in each book (i.e., that had an animal as their subject, except in the case of labeling) were selected as utterances to be coded. Utterances that referred to aspects of the background scene (e.g., "Look at that moon") and events in the child's life (e.g., "Remember when we saw a lion at the zoo?") were not included in the coding.

Utterance framing: generic subject, specific subject, or labels

The utterance framing coding scheme was adapted from Gelman et al. (2005), who coded for generic phrases, individuating phrases, and ostensive labeling phrases. Under the Gelman et al. (2005) coding scheme, generic phrases included those with bare plurals (e.g., elephants), indefinite singulars (e.g., an elephant), and definite singulars (e.g., the elephant) as their subject. Specific (individuating) phrases included those with proper names (e.g., Babar), singular pronouns (e.g., he/she), and count nouns (e.g., some elephants) as their subject. Given that the picture books used in this study only included labels for the animals and not proper names (e.g., Babar), parents' commonly referred to specific animals using definite singulars (e.g., The elephant is sleeping.). Thus, such definite singular constructions were coded as specific in all cases. Labeling phrases were those that served to place an individual in a category (e.g., "that's a lion") and did not contain any additional descriptive information (e.g., "that's a funny-looking hyena").

Utterance content: physical descriptions, natural facts, and story-specific utterances

In an initial look at our transcripts, we noticed that mothers would often make kind-relevant statements using a specific subject (e.g., a singular pronoun: "he says roar"). Thus, all the generic and specific subject utterances identified were further coded with respect to *utterance content*. In particular, each utterance's content was coded as either physical description, story-specific, or natural fact. **Table 1** provides more detailed descriptions and examples of the coding of utterance content. Via this coding, we sought to determine whether the two picture book genres differed in the extent to which they stimulated talk about the animals that provided unobservable natural facts vs. information about observable characteristics (physical descriptions) and depicted states and events (story-specific). Our primary interest was in natural facts, because it is this type of information that is often expected to be conveyed using generic language.

Two coders, one blind to the purpose of the study, coded the utterances that referred to animals, as described above, in all 50 transcripts. Coding agreement was excellent for both utterance framing ($\kappa = 0.90$) and content ($\kappa = 0.96$).

RESULTS

Overall, as reported in Nyhout and O'Neill (2013), mothers produced an average of 50.40 ($SD = 30.36$) utterances during narrative book sharing and 35.56 ($SD = 14.58$) utterances during non-narrative book sharing, $t_{(24)} = 2.90$ $p = 0.008$. Note that the greater quantity of talk during narrative book sharing can mostly be attributed to the presence of the background scene, which was present in the narrative versions, but not the non-narrative versions of each book. Mothers had the opportunity to discuss aspects of the background scene during narrative book sharing (e.g., a snowy tree, the animals' cages). Because mothers talked significantly more during narrative book sharing, Nyhout and O'Neill (2013) analyzed results for both frequency and proportion, as we will also report here with respect to the proportion of total maternal utterances (see **Table 2**). In most cases, the proportion results paralleled the frequency results. As such, we only present proportion results when they deviate from the frequency results in terms of patterns of significance. In cases of violations of the assumption of sphericity, we made Greenhouse-Geisser adjustments to the degrees of freedom. Because many of the children in the study produced only single-word utterances, or utterances that were unintelligible, we present only data on mothers' utterances. There were no significant effects of book version (e.g., narrative *Zoo* vs. narrative *Woods*), order

Table 1 | Description and examples of the three subcategories for the utterance framing and utterance content categories.

Coding category	Subcategory	Description	Examples
Utterance framing	Generic	Utterances that include bare plurals or indefinite singulars as their subjects	"Squirrels like to climb trees" "A hyena looks like a dog"
	Specific	Utterances that include definite singulars*, proper names, singular pronouns, or count nouns as their subjects	"The bear is sleeping" "He's getting out of his cage"
	Labels	Utterances that designate a particular animal as a member of a kind	"Now, this is a hare" "He's a gorilla"
Utterance content**	Physical description	Utterances that describe an observable, physical property of the animal	"Giraffe has a long neck" "A badger is black and white"
	Story-specific	Utterances that describe a specific action or state of an animal in the story	"The gorilla is unlocking the cage!" "The bear is sleepy"
	Natural fact	Utterances that describe an unobservable property of the animal. These included utterances that classify the animal, or provide information about the animal's habitat, behavior (e.g., animal sounds), or diet	"He's a type of ape" "The hyena says (makes laughing noise)"

*As described on p. 11, given the nature of the books used, definite singular constructions were more appropriately coded as instances of specific framing rather than generic framing, in contrast to Gelman et al. (2005).

**Labels were not included in this level of coding.

Table 2 | Mean (SD) frequency and proportion of utterances for each utterance framing and content type for narrative and non-narrative books.

	Generic		Specific		Label		Physical description		Story-specific		Natural fact	
	Narr	NonN	Narr	NonN	Narr	NonN	Narr	NonN	Narr	NonN	Narr	NonN
Frequency	1.68	1.56	8.72^a	5.64^b	7.84	9.32	0.76^a	2.72^b	7.52^a	1.64^b	2.16	2.84
	(2.02)	(1.33)	(5.03)	(4.13)	(5.01)	(3.59)	(0.97)	(2.81)	(4.79)	(2.00)	(2.12)	(1.89)
Proportion: total maternal	0.04	0.05	0.19	0.16	0.18^a	0.31^b	0.02^a	0.07^b	0.16^a	0.05^b	0.05	0.09
	(0.06)	(0.05)	(0.10)	(0.13)	(0.09)	(0.20)	(0.02)	(0.08)	(0.10)	(0.06)	(0.06)	(0.06)

Means with different superscripts for narrative and non-narrative within each category were significantly different at $p < 0.0125$.

of book presentation, or child gender, so all results are analyzed together.

UTTERANCE FRAMING

To investigate our question of whether book genre influenced the framing of utterances mothers used, we conducted 2×3 repeated-measures analyses of variance (ANOVA) with book genre (narrative or non-narrative) and utterance framing type (generic, specific, or labeling) as within-subjects factors for both frequency and proportion data.

Frequency

Results of the frequency ANOVA demonstrated that there was no significant main effect of genre: the narrative ($M = 18.24$, $SD = 8.15$) and non-narrative genres ($M = 16.52$, $SD = 5.44$) did not differ in terms of the average number of animal-referring utterances they elicited, $F_{(1,\ 24)} = 1.46$, $p = 0.238$, $\eta_p^2 = 0.06$. There was, however, a difference between the three utterance framing types when combined across genre, $F_{(1.49,35.74)} = 40.94$, $p < 0.001$, $\eta_p^2 = 0.63$. To explore this difference in further detail, we conducted *post-hoc* *t*-tests with a Bonferroni-corrected α-value of 0.0125, as was the case with all other *post-hoc* tests described below. Collapsing across genre, the frequency of generic statements ($M = 1.62$, $SD = 1.29$) was significantly lower than the frequency of labels ($M = 8.58$, $SD = 3.37$), $t_{(24)} = 11.38$, $p < 0.001$, and the frequency of specific statements ($M = 7.18$, $SD = 3.91$), $t_{(24)} = 7.29, p < 0.001$. The frequencies of labels and specific statements did not differ significantly, $p = 0.181$.

Turning to the main results of interest, we found that the genre by utterance framing type interaction was significant, $F_{(2,\ 48)} = 6.36$, $p = 0.004$, $\eta_p^2 = 0.21$. **Figure 1** displays the results of this interaction. The frequency of *generic statements* did not differ significantly between narrative and non-narrative book sharing, $p = 0.791$. The frequency of *labels* also did not differ significantly between narrative and non-narrative book sharing, $p = 0.192$. The frequency of *specific statements* was significantly greater during narrative book sharing than during non-narrative book sharing, $t_{(24)} = 5.08, p = 0.004$. See **Table 2** for a display of the means of frequency and proportion interactions.

Proportion

The patterns of significance for the main effects and interaction echoed those for the frequency analysis. Two differences were however found with respect to the *post-hoc* *t*-tests for the interaction. None of these differences concerned generic statements. First, recall that when comparing frequency, the two genres did

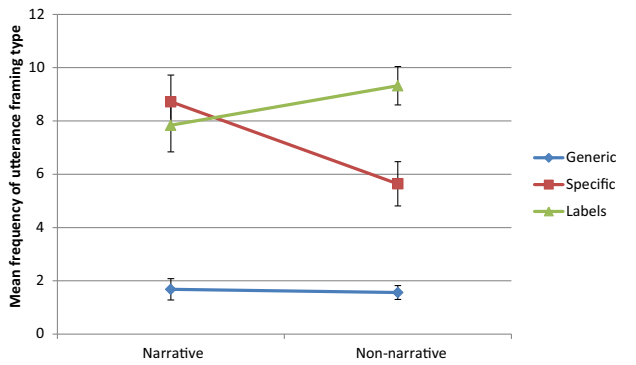

FIGURE 1 | Mean frequency (±SE) of generic, specific, and labeling statements across narrative and non-narrative book sharing.

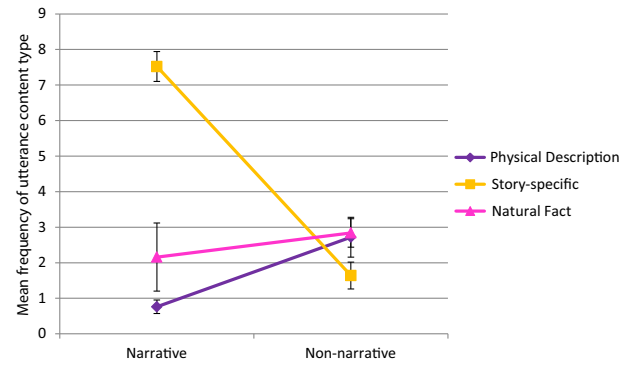

FIGURE 2 | Mean frequency (±SE) of physical description, story-specific, and natural fact statements across narrative and non-narrative book sharing.

not differ in terms of the mean number of labels they elicited from mothers. However, labeling was significantly greater during non-narrative book sharing than during narrative book sharing when analyzed as a proportion of total maternal utterances. Second, recall that there were significantly more specific statements during narrative book sharing than during non-narrative book sharing. This difference did not hold when compared as a proportion of *total* utterances ($p = 0.193$).

Utterance content

To investigate our question of whether book genre influenced the content of mothers' utterances, we conducted 2 × 3 repeated-measures analyses of variance (ANOVA) with book genre (narrative or non-narrative) and content (physical description, natural fact, or story-specific) as within-subjects factors for both frequency and proportion data.

Frequency

Of the generic and specific utterances coded further for content, significantly more occurred during narrative book sharing ($M = 3.48$, $SD = 1.92$) than during non-narrative book sharing ($M = 2.40$, $SD = 1.61$), $F_{(1,\ 24)} = 7.42$, $p = 0.012$, $\eta_p^2 = 0.24$. There was also a significant difference between the three utterance content categories when combined across genre, $F_{(1.50,35.87)} = 17.13$, $p < 0.001$, $\eta_p^2 = 0.42$. Collapsing across book genre, the frequency of story-specific utterances ($M = 4.58$, $SD = 2.79$) was significantly greater than the frequency of both physical descriptions ($M = 1.74$, $SD = 1.54$), $t_{(24)} = 4.83$, $p < 0.001$, and natural facts ($M = 2.50$, $SD = 1.61$), $t_{(24)} = 3.77$, $p = 0.001$. The frequencies of natural facts and of physical descriptions were not significantly different when correcting for multiple comparisons, $t_{(24)} = 2.32$, $p = 0.029$.

Turning to the main results of interest, there was a significant genre by content interaction, $F_{(1.53,\ 36.60)} = 35.85$, $p < 0.001$, $\eta_p^2 = 0.60$. **Figure 2** displays the results of this interaction. We found that mothers' use of physical descriptions was significantly greater during non-narrative book sharing than during narrative book sharing, $t_{(24)} = 3.44$, $p = 0.002$. Mothers' produced significantly more story-specific utterances during narrative book sharing than during non-narrative book sharing, $t_{(24)} = 6.17$, $p < 0.001$. Of most interest, there was no significant difference across genres in the frequency of natural facts, $p = 0.165$.

Proportion

The patterns of significance for the main effects and interaction were the same, regardless of whether the results were analyzed by frequency or proportion of total maternal utterances. It is noted for the reader, that although the proportion of natural facts was higher during non-narrative book sharing than narrative book sharing, the difference was not significant when corrected for multiple comparisons.

DISCUSSION

The influence of placing animal characters in a narrative or non-narrative picture-book context on mothers' use of certain types of pedagogical language was investigated in the present study. Because the target animals did not differ between the two genres, and each book presented the six target animals' labels as the only text, the key difference was in whether the animals were presented within illustrations depicting a story (narrative condition) or on a blank page (non-narrative condition). There were no differences across genres in terms of the frequency or proportion of total utterances that were about the animals in the books (i.e., animal-referring). Dividing these animal-referring utterances into generic, specific, and labeling subtypes, we found that specific utterances were significantly more common during narrative book sharing. Surprisingly, however, the two genres did not differ in terms of the frequency or proportion of maternal generic utterances that they engendered. When analyzed by proportion, mothers' use of specific utterances did not differ across the two genres, whereas a greater proportion of utterances were labels during non-narrative book sharing. Thus, the key difference between the two genres was in their elicitation of specific and labeling utterances, not, as one might have predicted based on previous studies, generic utterances (e.g., Gelman et al., 2013).

When looking beyond the structure of mothers' utterances, we found differences in the types of content mothers were delivering during narrative and non-narrative book sharing. Whereas the non-narrative books encouraged more physical descriptions, the

narratives, somewhat expectedly, encouraged more story-specific utterances that described states of the animals and animal-related actions on the page. The books did not differ, however, in their propensity to encourage natural facts about the animals. Like the non-significant generic finding, this suggests that mothers do not necessarily take a more pedagogical stance during non-narrative book sharing. The natural fact category comprised utterances that provided information about animals' diet, habit, and behaviors. Note that the generic and natural fact categories were neither completely overlapping nor mutually-exclusive. Although natural facts and generic knowledge may be seemingly synonymous, we found that mothers presented natural facts using specific noun phrases on several occasions (e.g., "He (badger) uses his sharp claws and goes dig, dig, dig."). As such, the utterance framing and utterance content codings provide complementary, yet unique information.

The present findings add to a growing body of research indicating that contextual influences, and particularly the format of presentation of animals and objects, can influence the extent to which they are construed and spoken about as individuals or members of a kind (Gelman and Tardif, 1998; Gelman et al., 2005, 2013). Language referencing individuals and kinds differs not only across settings (e.g., objects vs. pictures; Gelman et al., 2005), but also within the book sharing setting, when the nature of the book is manipulated.

THINKING AND TALKING ABOUT INDIVIDUALS AND KINDS

What do these cross-genre differences in utterance framing and content tell us about how animals are construed in narrative and non-narrative contexts? The narratives, which present animals engaging in unique, intentional activities, appeared to prime mothers to think about the animals mostly as individuals, as reflected in the higher frequency and proportion of specific utterances. In other words, given a depicted event, mothers used specific language to describe it. But generic, kind-referring talk was also notably present during narrative book sharing. What is more intriguing, perhaps, is what mothers did with the non-narrative books. In a sense, one should have free rein to discuss whatever one likes about a picture of an animal on a page, as there is no need to convey a visual narrative to the child. Mothers provided a mix of physical descriptions, natural facts, and even some story-specific utterances during non-narrative book sharing. They did not appear, however, to treat the animals in the non-narratives as any more representational of their kind than those in the narratives.

Gelman et al. (2005) have argued that labels are more representational of kinds than specific utterances, but we would argue that labels only serve to place an individual in a category and offer little kind-based information if they are not followed with a generic statement. And, our finding that generics did not differ across genres suggests that mothers did not necessarily view animals in the non-narrative as more representational than those in the narrative. If pedagogical contexts do indeed encourage the communication of generic information, as suggested by recent studies (Gelman et al., 2005; Butler and Markman, 2012) and Csibra and Gergely's (2009) theory of natural pedagogy, then one could conclude from the present findings that mothers were not behaving more pedagogically during non-narrative book sharing than during narrative book sharing.

It is difficult to provide a conclusive answer to the question of whether animals were construed as individuals or as members of a kind in the narrative and non-narrative books by mothers, but, for now, the answer seems to be "both." Within each type of book, mothers shifted from describing an animal as a specific individual (e.g., narrative: "He's going to sleep in there, too"; non-narrative: "He kind of looks like a dog") to describing it as a member of a kind (e.g., narrative: "Squirrels eat nuts, don't they?"; non-narrative: "Hyenas laugh, hahaha"). Thus, mothers appear to flexibly consider a single animal as both an individual and as an exemplar when discussing it with their children.

It is worth acknowledging that, relative to other types of talk, the proportion of generics observed in the present study (4–5%) might be considered by readers to be fairly low. However, our observed proportion is similar to that of a previous study with a similar age group (19- to 23-month-olds) (Gelman and Tardif, 1998), in which 4.67% of maternal utterances included generic noun phrases during book sharing. Relative to other contexts (e.g., toy play) and subject matter (e.g., artifacts), the authors found that mothers' use of generic noun phrases was greatest during book sharing about animals. Thus, it would appear that a proportion around 4–5% may be quite typical of book sharing interactions between parents and toddlers. It is likely that as children's comprehension of generic language increases, so too does the amount of generic language they receive in their input. Future research may investigate whether the observed pattern, in which mothers' use of generic language is equivalent across narrative and non-narrative books, holds with slightly older children.

LEARNING FROM NARRATIVES AND NON-NARRATIVES

Together with our prior finding, using the same data set, that mothers' talk was more complex during narrative book sharing, with more text-to-life references, mental state terms, and non-present tenses, compared to non-narrative (didactic) book sharing (Nyhout and O'Neill, 2013), the present findings suggest that narratives do indeed provide ample stimulus for abstract and pedagogical types of talk, such as generic language and natural facts, previously assumed to fall more within the domain of informational books.

Anecdotally, many parents who have participated in studies in our lab have remarked that storybooks are "just for fun." Comments on websites such as Amazon frequently reflect this sentiment. This view may be widely held, given media reports on declining picture book sales in favor of chapter books and more "educational" books (Bosman, 2010). Our findings suggest however that, when sharing wordless books with their mothers, children are exposed to an equal amount of generic, factual information when the book is a narrative as when it is a non-narrative.

Increasingly, researchers and educators are emphasizing the need for children to be exposed to more informational texts both at home and in the classroom (e.g., Reese and Harris, 1997; Duke, 2000, 2003; Goodwin and Miller, 2013). A common argument is that as children shift from *learning to read* to *reading to learn*, they must have access to books that provide "information about the natural and social world" (Duke, 2003, p. 1). Proponents

of increasing children's exposure to informational books generally acknowledge that narratives do have their place, but not as potential sources of world knowledge. A key problem that we see with these views is in the strict dichotomization of narrative and informational texts. As demonstrated in the present study and as found in a content analysis of children's books (Gelman et al., 2013), narratives can and do provide generic information about the natural world. Given that our narrative and non-narrative books fostered equal numbers of generic utterances, a key consideration for parents hoping to expose their children to more educational materials should be enjoyment. Those books that parents and children find more enjoyable should maintain attention and potentially facilitate greater learning.

The focus of future investigations should now turn to how and what children learn from narrative and non-narrative books, in both controlled experiments and in more open-ended interactions with caretakers. Previous findings are somewhat mixed in terms of whether children are able to learn factual information from fiction (Fazio and Marsh, 2008; Richert et al., 2009; Richert and Smith, 2011). Most relevant to the present study, perhaps, are the mentioned findings by Ganea et al. (2011), who found that children were able to learn and generalize from both factual and intentional picture book formats. How the two types of books, narrative and non-narrative, may differentially support learning should be a focus of future research. Although our narrative and non-narrative books promoted a relatively equal proportion of generic language, it is unknown to what extent the interactions around the two types of books may have fostered short- and long-term *learning* of information about the featured animals.

TODDLERS' REASONING ABOUT ANIMALS AND OBJECTS IN BOOKS

Three important questions about children's comprehension and reasoning for future research arise from our observations of mothers' shifting use of specific and generic language use during book sharing.

(1) *To what extent do children under 2 years of age distinguish between syntax referring to individuals and syntax referring to kinds?* Gelman and Raman (2003) found that 2-year-olds were able to distinguish between questions referring to individuals (e.g., "What color are the dogs?") and kinds (e.g., "What color are dogs?") It is unknown how children younger than 24 months may interpret these different sentences. What do children of the age in our study think "This elephant loves peanuts" refers to: the elephant on the page, or all elephants?

(2) *Do children construe the animals they encounter in books as individuals, members of a kind, or both?* Because mothers switched between specific and generic utterances frequently, and because there is currently no evidence that children under 2 years of age can distinguish between generic and non-generic syntax, it is worth considering how children may spontaneously conceive of the animals and objects they encounter in books and how this may influence their learning. Intriguingly, it seems that children have a natural propensity to consider and express generics from an early age. Preschoolers who had not been exposed to conventional language (deaf children of hearing parents) produced generics in their home sign system (Goldin-Meadow et al., 2005). However, we do not know what tendency young children have to consider animals in books and pictures and whether narrative context may influence this. It would be of interest to investigate toddlers' and preschoolers' comments about animals in the two types of books when they are asked by a parent or experimenter to provide them.

(3) *Can toddlers shift between representing the same entity as both an individual and as an exemplar?* By the age of three, children are capable of a relevant representational ability: dual representation, the ability to represent a symbol both as standing for something else and as a concrete entity itself (DeLoache, 2000). In the case of the toddlers in our study, the question is whether they can consider the animals in our books both as individual characters carrying out unique activities and as exemplars of a kind. The 3- and 4-year-old children in Ganea et al.'s (2011) study were likely able to represent the animals in the intentional, narrative condition as individual characters and as members of a kind, evidenced by their ability to generalize the information learned. It is unknown whether the toddlers in our study were able to consider the unique activities of the animals on the page (e.g., a squirrel sneaking into a bear's den to keep warm), while also making predictions about the kind-relevant activities the animals must engage in (e.g., collecting and hiding nuts). Many of the children in the present study frequently produced animal sounds for known animals in the books, both spontaneously and when requested by mothers. This suggests that they readily considered the animals on the pages as exemplars of a kind.

CONCLUSION

Much of the information we possess about the world comes from the books we read, the films we watch, and the people we converse with. Although non-fiction books and documentary films may first come to mind when one thinks about the genres of media that are likely to provide natural facts about the world, the present findings suggest that both narrative and non-narrative children's picture books stimulate such pedagogical talk from mothers. While the narrative books promoted more references to individual characters, the non-narrative books elicited more instances of labels. Surprisingly, the two types of books encouraged similar amounts of generic talk about kinds of animals and talk about natural facts. Based on these findings, we leave the reader with one final piece of generic information: picture book stories aren't just for fun; they're for learning, too.

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Clues cue the smooze: rhyme, pausing, and prediction help children learn new words from storybooks

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Rhyme, which is ubiquitous in the language experiences of young children, may be especially facilitative to vocabulary learning because of how it can support active predictions about upcoming words. In two experiments, we tested whether rhyme, when used to help children anticipate new words would make those words easier to learn. Two- to 4-year-old children heard rhyming stanzas naming novel monsters under three conditions: A non-rhyme condition in which novel monster names appeared as unrhymed elements within a rhymed stanza, a non-predictive rhyme condition in which the novel names were the rhymed element in the first line of a stanza, and a predictive rhyme condition in which the monster name came as the rhymed element in the last line of the stanza after a description of the features that distinguished him. In tests of retention and identification children showed greatest novel name learning in the predictive rhyme condition in both between-subjects (Experiment 1) and within-subjects (Experiment 2) comparisons. Additionally, when parents acted as the storybook readers in Experiment 2, many of them distinctly paused before target words in the predictive rhyme condition and for their children a stronger predictive rhyme advantage surfaced. Thus rhyme is not only facilitative for learning, but when the novel vocabulary is specifically in a position where it is *predictable* from the rhymes, it is most accessible.

Keywords: shared storybook reading, word learning, vocabulary growth, rhyme, predictable language, preschoolers

INTRODUCTION

Recently, my 3-year-old son asked, "Guess what's in my pocket?" then paused for a beat and exclaimed, "a wocket!" And, while thankfully there was not actually a small Seussian monster in his pants, my son had reminded me of just how well he is able to learn words (even nonsense words) from storybooks, and in fact just how strongly rhyme must influence that process.

Shared storybook reading is a triangular interaction—the adult reader, the child, and the book conspire to create a meaningful experience each time a book is shared; and one of the many benefits for young children who regularly share in storybooks with their parents is the positive impact that has on their vocabulary growth (Senechal et al., 1996; DeTemple and Snow, 2003; Blewitt et al., 2009; Farrant and Zubrick, 2013). Books present new words to young listeners, parents actively highlight those new words, expand on them, and help to make them memorable for the child (e.g., Clark, 2010). Even in the earliest years caregivers use storybooks as a vehicle for pointing out new vocabulary (Ninio, 1983; Moerk, 1985; Fletcher and Reese, 2005), but for 2- to 5-year-olds in a rapid period of word learning, storybook reading is the perfect opportunity to hear an abundance of new words in engaging contexts, and to take part in questions and conversations which promote vocabulary learning (Ard and Beverly, 2004; Blewitt et al., 2009).

Of course, the connection between storybook reading and vocabulary growth is not always a simple one. Learning words from books is mediated by many factors—the frequency of reading (Bus et al., 1995; Senechal and LeFevre, 2002), the age when regular storybook reading begins (DeBaryshe, 1993; Senechal and LeFevre, 2002), the word-knowledge children bring to the experience (Senechal et al., 1995; Hindman et al., 2008; Blewitt et al., 2009), the style of adult readers including the amount of elaboration on the meaning of new words (Ard and Beverly, 2004; Justice et al., 2005), and the complexity of adult readers' elaborations and questions about the book while reading (Whitehurst et al., 1988; Reese et al., 2003; Hindman et al., 2008; Blewitt et al., 2009). Typically, a more dialogic reading style by parents with open-ended questions, elaborations and repetitions which encourages the child to comment on the book (e.g., Whitehurst et al., 1988, 1994) can lead to better vocabulary learning. For instance, Ard and Beverly (2004) found that children learned more novel words from storybooks when they heard extra comments or questions about those words during the reading session. Hindman et al.'s (2008) longitudinal study of preschoolers reading with parents and teachers went one step further. They discovered that it was not just extra talk about the meanings of new words that affected word learning, but specifically talk that prompted children to recall, predict, and make inferences when reading stories that predicted gains in children's vocabulary. Thus, simply hearing new words in storybooks can help a child learn those words, but *actively* engaging with the words seems to provide an extra memory and learning boost.

So while we have amassed research on the role adult readers play in promoting word learning from storybooks and what characteristics of children may make them more receptive, we know much less about how the third part of this interaction, the book

itself, helps to encourage word learning. Do some books prompt more active engagement on the part of the child? Are there features of certain types of books that might encourage more questions, more predictions, or simply more memorable words? In particular, what difference does rhyme, a ubiquitous storybook feature, make in helping children grow their vocabulary?

Almost thirty years ago, Moerk (1985) speculated on the potential benefits of rhyme, which, like repetition, increases predictability, and may thereby "simplify the analysis of the input for the child" (p. 553) making it easier for children to remember words from a story. He had observed mothers capitalizing on the predictability of rhyme when reading with children in a "testing and feedback" phenomenon that involved deliberately producing incomplete utterances leaving off the last word of a rhyme so that children could easily supply it (Moerk, 1972), yet he did not measure the effects of this kind of interaction on how well children might retain those rhyming words in their vocabulary. In fact, despite the ubiquity of rhyme in the life of a preschooler and the intuitions of parents and teachers (e.g., Kenney, 2005), only a small amount of empirical research has looked at whether children's books written in verse affect what is learned from them.

Rhyme is so common in the modern child's experience of shared storybook reading that we sometimes overlook it, but in a recent local survey of 160 parents of 2- to 4-year-old children, parents reported that on average rhyming books make up 38% of their home libraries, and of their own favorite books to read to their children 48% were rhyming (Read, Unpublished raw data). In fact, 20 of the "Top 100 children's books of all-time" (2013) for children ages 0–5 are in verse. Thus, a child who is read to regularly could be hearing hundreds of hours of rhymed language before the end of preschool. Children don't just hear a lot of rhyme they also clearly enjoy it. In Hayes et al.'s (1982) experiments, which pitted rhymed versus unrhymed versions of stories against one another for the purpose of testing children's recall, regardless of how well children remembered them, they consistently *liked* the rhyming versions of the stories significantly more than the prose versions. This seems unsurprising as it fits anecdotally with the first-hand experience of parents, teachers, and children's book writers, but *what* is the advantage to rhyme over prose besides the delight in it?

Experience with rhymes, whether gleaned from storybooks or simply recited orally, does correlate positively with other measures of language development. In a meta-analysis of 12 studies with 5299 3- to 6-year-olds, Dunst et al. (2011) found that nursery rhyme measures (e.g., knowledge of, or experience with specific nursery rhymes) were positively associated with several phonological and pre-literacy measures. The link from rhymes to reading outcomes is assumed to proceed through heightening phonological sensitivity (e.g., Bryant et al., 1989; Hayes, 2011). But our own query is more specific—could rhymes help foster language development because they make the vocabulary within them more predictable and thus easier to remember?

Two researchers in the last 40 years who have directly compared what children remember from prose vs. rhyming stories have found different things: Hayes and colleagues found 4- to 6-year-olds were hampered by rhyme when asked to recall the specific events of a story (Hayes et al., 1982; Johnson and Hayes, 1987; Hayes, 1999). However, Sheingold and Foundas (1978) found that 6-year-olds recalled just as many details of a story when they heard rhyming vs. prose versions, but that the rhymed stories gave children an advantage in memory for the sequence of events. In addition, children recalled more of the specific rhyming words of stories compared to other details (Hayes et al., 1982) and demonstrated better verbatim recall (Johnson and Hayes, 1987) despite decrements in overall paraphrase abilities.

Recently our own work has investigated the effects of rhymed versus unrhymed stories on 2- to 4-year-old children's ability to recall familiar animal names from a parent–child storybook reading session (Read and Macauley, submitted). We found not only that children remembered more target words when they had been presented in a rhymed story, but also that parents reading rhymed versions of the story would pause longer before naming a target animal and that in concert children would spontaneously guess the name of the animal during such pauses with significantly higher accuracy in the rhyming condition. Just as Moerk (1972) observed, a parent in this study would read *My floppy ears might look quite funny/if I were a hopping…* allowing the child time to supply *bunny!*, and then at the end of the book *bunny* was more easily recalled in this rhyme version than in a unrhymed version about the very same rabbit. This highlighted the way that rhyme supports predictability, but also how that predictability might be making the words themselves more memorable. Thus, rhyme, as well as being potentially engaging and playful, may be especially facilitative for recall because of how it can support active predictions about upcoming words.

Thus if rhyme is helpful to children for remembering such predictable familiar words, the question that follows is whether it could also aid in learning *new* words. This may be the case because stories written in verse increase the amount of overall predictability in the phrases children hear. Rhyme builds up an expectation for the sounds of upcoming words even if they are unfamiliar, and added to other cues like the story narrative or illustrations, can give a child clues about the form of a novel word at the end of a line even before it is read.

Recent research demonstrates how predictability gives children an edge in language comprehension and language learning. When words are predictable, for example when they are placed in frequent frames (Fernald and Hurtado, 2006) or common phrases like *brush your…teeth* (Arnon and Clark, 2011) or contextually specific phrases like *the pirate buried the…treasure* (Borovsky et al., 2012) then those words can be anticipated and identified more rapidly (Fernald and Hurtado, 2006; Borovsky et al., 2012) and produced correctly more often (Arnon and Clark, 2011). Predictability also influences how well children learn novel words. Ramscar et al. (2010) demonstrated the importance for word learners (whether they are children, adults, or computer models) of sequencing information in a way that facilitates prediction. They found that when a novel label is *preceded by* the discriminating features of a novel object then that label can be learned more easily, meaning that the most supportive thing we can do to teach a new word is to name it *after* the features that predict it.

Could a similar kind of predictability, the kind that rhyme adds to language as a redundant cue to the relevant features and the sound of a new word, also make that new word more memorable,

and thus more learnable? The present study was designed to look not just at whether rhyme would aid memory for words from storybooks, but whether the specific way in which the rhyme sets up those new words would make a difference to how well children could retain and learn them. If rhyme makes words more memorable simply because it makes a storybook more engaging, then it would not matter where a new word was placed within a rhyming stanza, that word should still receive a boost. If rhyme makes words more memorable simply by highlighting them phonologically through the repetition of sound, then only novel words that are rhymed elements themselves should benefit. However, if the *predictability* that the rhyme creates is what boosts memory and learning then where the novel word is placed within a stanza should matter—putting the new word in the most predictable place at the end of the stanza after drawing attention to the novel features that distinguish it, and setting up an expectation for what it should sound like should be most beneficial for remembering and learning that new word. Thus, in two experiments we attempted to teach young children the novel names of several unfamiliar monsters under each kind of rhyming condition—one in which the monster name, though embedded within a rhyme, was not a rhyming element itself; one in which the monster name was a rhyming element but it was the first one heard; and one condition in which the monster name was the last rhyming element in a four-line stanza meant to provide the maximal amount of predictability.

EXPERIMENT 1

METHODS

Participants

Twenty-six 2- to 4-year-old children participated ($M_{age} = 39$ months, $SD = 9.5$ months). Eighteen participants were girls and eight were boys. All were learning English as their primary language without any reported language delays or disabilities. Children were recruited through an on-campus preschool in Santa Clara, California, and tended to be from homes in which parents were college-educated and of moderate to high income levels. Children were randomly assigned to each of three conditions resulting in equal distribution of ages and genders among groups. **Table 1** illustrates the age and gender breakdown of each condition group. We conducted a one-way analysis of variance in order to test for any significant difference in ages among condition groups, and found none, $F_{(2,23)} = 0.518$, $p = 0.602$. One additional child participated but was excluded from all analyses due to inattentiveness and failure to participate in answering the test questions.

Table 1 | Age and Gender breakdown of each Condition Group in Experiment 1.

Condition	Mean age (months)	95% CI for age (months)	Number of girls/boys
Non-rhyme	36.4	[29, 43]	7/3
Non-predictive rhyme	39.3	[31, 48]	6/2
Predictive rhyme	40.8	[33, 49]	5/3

Materials

Three "laptop stories"—one for each condition—were created for Experiment 1. Each story was a six-page rhyming introduction to a series of novel friendly monsters. Each page in the story featured a new monster on a white background, and the text of one rhyming stanza describing him. The monster pictures were bold-color cartoon-style drawings of monsters thought to be "cute" and "friendly" by a norming sample of five preschool-aged children. Each monster was illustrated to have a prominent feature (e.g., extra-large shoes, a big fuzzy nose) that was described within the rhyming stanza that accompanied his picture. The monster names were all one syllable, and each started with one of three consonant clusters and ended in a common rime. This was done so that we could create novel names that would, nonetheless, rhyme with features that would be common words even for children as young as two. (See Appendix for the full text of all the rhymes and monster names used in each condition).

Each of the rhymes was recorded by a single female reader using GarageBand© recording software in a soundproof recording room. The reader used a child-friendly, evenly paced tone, and all stanzas were approximately the same volume and duration (between 11 and 12 s), as were all target monster names (between 700 and 950 ms).

The pages of each story were adapted into Powerpoint© software as individual slides with each monster picture and recorded text coupled. After the story slides, a slide with just the text "Time to help out!" was added, followed by six more slides each with a pair of monsters from which a child would be asked to choose a target (never pairing two monsters with the same initial consonant cluster, and never presenting the same pair twice). Then, another plain text slide was inserted that read, "Can you say their names?" followed by the six monster pictures again presented one-by-one so that the child could be asked to produce a name for each. Animation was added to all the slides so that the "pages" would appear to turn like conventional print book pages from right to left automatically every 12 s.

Procedure

The study was conducted in a small quiet room meant to be inviting to children but relatively free of distractions at the children's preschool. Children whose parent had given consent for their participation were approached individually by the experimenter and asked if they would like to listen to a story "on the computer." When children gave assent, they were shown to the testing room and seated at a small table with a 15" MacBook Pro® laptop. The video camera built into the laptop was turned on using the Photo Booth© application so that the child's responses could be recorded. The stories were displayed using Powerpoint© software that was set to automatically advance through the pages and play the audio recording of the text on each page, similar to an e-book. Each child was told that after the story the experimenter would ask some questions about the names of the monsters.

Children were randomly assigned to one of three between-subject conditions and heard the corresponding story. The pictures of the monsters and the order in which they were presented were identical in each condition; what differed among conditions was the placement of the monster name within the stanza and

whether it was rhymed with the distinguishing features of the monster. In the non-rhyme condition, the monster name came within the first line and did not rhyme with the feature that distinguished it (though the stanza, itself, still rhymed). In the non-predictive rhyme condition, the name of the monster was a rhyming element, but came at the end of the first line, *before* the description of his unique rhyming feature. In the predictive rhyme condition each monster's name rhymed with his unique feature and came at the *end* of the four-line stanza.

After hearing the story, children were presented with monster pairs and asked to choose the named monster by pointing to his picture, e.g., "Which monster was the smooze?" as a test of novel name retention and identification. Then, children were shown pictures of each monster and asked the production test question, "What was this monster called?" For all questions, if children said that they didn't know they were asked if they wanted to make a guess, and regardless of how children answered, they were always praised for effort and reminded that this task was hard for the experimenter, which is why she needed their help.

Children's responses to both sets of questions were recorded during testing by one experimenter and then checked against the video-recordings later the same day by a second experimenter. Agreement between the two experimenters was greater than 98%. Children were given credit for a correct response on identification questions if they pointed first to the target monster or if they verbally described it, e.g., "He's the green one." Children were given credit for a correct response on production questions if they said the name of the monster or a close approximation that rhymed, e.g., "He's a smooze" or "a mooze." For each child we tallied the number of correct responses (out of six) for both identification and production test questions separately.

RESULTS

Descriptive statistics for children's age and performance on the task in each condition are given in **Table 2**.

In order to investigate the effects of rhyme and rhyme placement on children's success in our tasks we did separate analyses of covariance (ANCOVAs) for the identification task and for the production task. For the identification task, an ANCOVA with condition as a between subjects' factor and age as a possible covariate revealed a significant effect of condition on performance in the identification task, $F_{(2,\ 22)} = 4.781$, $p = 0.02$ but no significant effect of age, $F_{(1,\ 22)} = 1.912$, $p = 0.18$, meaning that children's ability to correctly identify a monster in our task was affected by which condition they were in regardless of their age. The size of the effect of condition on identification scores was moderate, $\eta^2 = 0.26$. *Post-hoc* Tukey HSD tests were conducted to test children's performance in each condition pair-wise, and these revealed that the overall effects for the identification test comparison were driven by significantly greater performance in the predictive rhyme condition than the control non-rhyme condition, $p < 0.05$ with performance in the non-predictive rhyme condition falling in between the other two conditions without differing significantly from either.

Table 2 | Response performance by Condition in Experiment 1.

	Condition		
	Non-rhyme rhyme mean 95% CI	**Non-predictive rhyme mean 95% CI**	**Predictive rhyme mean 95% CI**
% Correct monster identifications	40_a [27, 53]	58_{ab} [45, 72]	65_b [45, 83]
% Correct monster name productions	0	5 [−3, 12]	8 [0, 17]

CI, confidence interval; means that do not share subscripts differ from one another at $p < 0.05$.

For the production task, an ANCOVA with condition as a between subjects' factor and age as a possible covariate revealed no significant effect of condition on performance in the production task, $F_{(2,\ 22)} = 2.164$, $p = 0.14$ and only a marginal but not significant effect of age, $F_{(1,\ 22)} = 2.960$, $p = 0.10$, meaning that older children were not significantly more likely to successfully name a monster in any condition over another, and that while age may have had some effect it was also not a significant predictor of children's ability to produce monster names correctly. In addition, production test scores should be interpreted with caution, as there was clearly a "floor effect" skewing the distribution given that 20 out of the 26 participants could not name one monster.

DISCUSSION OF EXPERIMENT 1

These results indicate that the condition that promoted the best retention of the novel monster names was, as we hypothesized, the condition that provided children with the maximal amount of predictability. In other words, when the monster name came after the feature that distinguished that monster and when the sound of the monster's name could be predicted from three prior rhyming elements, then the name-monster mapping was easiest for children to recall. The finding that performance of children in the non-predictive rhyme condition did not differ from either of the other conditions hinted that simply using the novel name as a rhyming element at the beginning of the stanza, where it also received line-final stress but was less predictable may have not have been enough to make it more memorable than a non-rhyming novel name. However, because the difference between performance in the predictive and non-predictive rhyme conditions was not statistically significant, we could not be certain that placement alone (rather than a combination of placement and rhyme) was the important contributing factor. In order to focus in on the comparison between the most predictable rhymed novel words and the less predictable but still rhymed novel words, and to reduce the amount of extraneous variability inherent in a between subjects comparison of young children, we designed Experiment 2 as a within-subjects comparison of just the predictive and non-predictive rhyme conditions.

In addition, perhaps unsurprisingly, identifying correct monsters when given their names in a two-alternative forced choice test appeared to be easier for children than producing their names spontaneously. The production test may have been especially taxing for young children because of their language or memory skills

in general but also because young children may not have been comfortable answering questions and speaking out loud to an unfamiliar adult. Producing the monster names required more memory of the monsters but also more verbal ability and more confidence than simply identifying the monsters when named. To improve the naturalness of the experience for children and potentially their comfort level we also moved to a parent–child reading of the books in Experiment 2 rather than a pre-recorded narration of the book.

We believed bringing parents into the lab along with their children would emulate the child's more typical storybook reading experience, and would allow children and their parents to control the pacing in a more natural way that might help them remember and learn the monster names more successfully. Having the parents read the stories to their children also enabled us to consider the impact of reading style variables (e.g., emphasis on new vocabulary, amount of extra-textual talk) on how well the monster names were retained from this type of storybook.

So, in Experiment 2, we attempted to improve on Experiment 1 by investigating performance in a new group of children of the same age who heard the same predictive and non-predictive rhymes from Experiment 1, but in a within-subjects design. And, instead of hearing the rhymes pre-recorded, children's caregivers read the stories naturally allowing for variation in overall timing, pauses, emphasis and extra-textual talk as they might use in a more common and comfortable storybook experience at home.

EXPERIMENT 2

METHODS

Participants

Twenty-eight 2- to 4-year-old children participated ($M_{age} = 40$ months, $SD = 8$ months). Sixteen of the participants were girls, 12 were boys. All were learning English as their primary language without any reported language delays or disabilities. Each participant brought one parent with them (three fathers, the rest mothers) who had been recruited through parenting groups and an on-campus preschool in Santa Clara, California. Participants tended to be from homes in which parents were college-educated and of moderate to high income levels. All children in the study were reportedly read to daily by the parent who accompanied them. Two additional children participated but were not included in any analysis – one child's video recording failed because of technical error, and one child was excessively distracted during the story and could not complete testing.

Materials

Four "laptop stories" were created for Experiment 2 using the pictures and rhymes from Experiment 1 with the addition of two new monsters and their accompanying rhymes (see Appendix). Each story in Experiment 2 included four monsters presented with the text from the predictive rhyme condition and four monsters presented with the text from the non-predictive rhyme condition interspersed in one of four orders—order A1 was the reverse of order A2 (e.g., if the groze was the first monster presented in A1, it was the last monster of A2), and orders B1 and B2 were the condition inverses of A1 and A2 (e.g., if the groze was presented in a predictive rhyme in A1, it was presented in a non-predictive rhyme in B1). As in Experiment 1, stories were created and presented using Powerpoint© software. Test pages for the identification and production tests were the same as in Experiment 1 with the two new monsters added. In Experiment 2 there was no recorded narration and there was no automatic timing added, as parents were asked to read the stories to their children at their own pace.

Procedure

The study was conducted in a small quiet room meant to be inviting to children but relatively free of distractions in an academic building on campus. At the beginning of the session there was a short play period, where children were invited to color a picture or play with a puzzle while the procedure and consent form were explained to the parent. Afterward, each child was asked if he or she would like to listen to his or her mom or dad read a story "on the computer." Children and their parents sat at a small table with a 15" MacBook Pro® laptop. As in Experiment 1, the video camera built into the laptop was turned on so that the story reading and child's responses could be recorded, and the stories were displayed using Powerpoint© software, so that the parents could easily read page-by-page at their own pace as they would with a conventional print storybook. Each parent was told to read the story naturally, the way they would at home, and each child was told that afterwards the experimenter would ask some questions about the animals in the story. Children were randomly assigned to one of the four orders and the corresponding story was opened for their parent to read.

Once the parent had read the story, the experimenter then asked the child if he or she liked the story and could help her remember some of the monster names. With the child's assent, the experimenter proceeded with the test questions by asking the child the two-choice identification questions and then the open-ended production questions in the same manner as in Experiment 1. Parents were seated behind children during this testing period so as not to give any cues (intentional or unintentional) about the monsters in question.

Measures

We were primarily interested in the effect of condition on how well children retained the novel monster names that they heard in the story, and so as in Experiment 1, we calculated identification and production scores for each child based on how many monsters they correctly chose or named during testing. However, we also took measures of each parent's reading in order to capture some of the individual variations that each parent and child brought to the storybook reading experience and to investigate those variables' impact on retention.

For each parent, we took two measures using just the audio of the story reading session converted into Audacity® sound editing software files for precision. First, we measured to the hundredth of a second the duration of the pause that preceded naming each target monster (e.g., the length of time from the offset of "called a" to the onset of "smooze"). Pause duration was averaged for each parent across the four monsters within each condition. This measure was meant to investigate whether there might be a difference between conditions in the amount of time parents allowed a child

to prepare for and anticipate an upcoming monster name and/or whether any such pause was correlated with later retention (e.g., Read and Macauley, submitted). Second, we measured the duration of each novel target label (e.g., the time it took the parent to say "smooze"). While in both conditions, the monster names were expected to receive sentence-final stress and perhaps emphasis because of their novelty (e.g., Fernald and Mazzie, 1991; Clark, 2010), this measure was meant to investigate whether the emphasis parents placed on the name of the animals differed based on whether they were in the predictive rhyme or non-predictive rhyme condition and/or was correlated with later retention. And third, we measured the average overall duration of the rhyme stanza for each parent in each condition as a way of investigating whether there was an effect of condition on parents' pacing and/or whether it correlated with later retention.

Lastly, we also measured parents' extra-textual talk in Experiment 2 by counting the total number of utterances that each parent made between starting the first stanza and the beginning of the test questions. Extra-textual talk included comments such as, "Oh he's cute," "wh" questions such as, "What is that guy doing?" and responses to children's questions, but not self-corrections or comments directed to the experimenter. This measure was meant to capture the total amount of story-related commentary as an indicator of the parents' reading style (e.g., Reese et al., 2003) in order for us to investigate whether reading style differed by condition and/or correlated with later retention.

Each of these measures was double-coded by trained research assistants to establish inter-rater reliability greater than 90%. Whenever there was disagreement, a discussion among the raters and the primary investigator settled the final measure.

RESULTS

Descriptive statistics for children's performance on the task and measures of parents' reading in each condition are given in **Table 3**.

The main question of Experiment 2 was whether children differed in their ability to correctly identify the novel monsters between conditions. An ANCOVA with condition as a within subjects' factor and age as a possible covariate revealed a significant effect of condition on performance in the comprehension task, $F_{(1,\ 26)} = 9.258$, $p = 0.005$, and no comprehension by age interaction, $F_{(1,\ 26)} = 0.002$, $p = 0.96$. Thus, children identified significantly more monsters correctly in the predictive rhyme condition than in the non-predictive rhyme condition, and the effect between conditions was moderately large, cohen's $d = 0.66$. Children identified more monsters correctly when they had been presented at the end of the stanza than when they were introduced at the beginning.

There was not, however, a significant difference between conditions in monster name productions. An ANCOVA with condition as a within subjects' factor and age as a possible covariate revealed no significant effect of condition on performance in the production task, $F_{(1,\ 26)} = 0.262$, $p = 0.61$, and no production by age interaction, $F_{(1,\ 26)} = 0.000$, $p = 0.99$. As in Experiment 1, there seemed to be a "floor effect" skewing the distribution of production scores such that 13 of the 28 children (almost half) never produced a single name.

Within-subjects comparisons of the parent reading measures in Experiment 2 uncovered no differences between the predictive and non-predictive rhyme conditions (all p's > 0.06), except for in the duration of the pause parents took before they named the monster. Parents paused before naming a monster significantly longer when reading predictive rhymes compared to non-predictive rhymes, $t_{(27)} = 2.81, p < 0.01$ (two-tailed) and the size of this effect was moderate, cohen's $d = 0.66$. In fact, as can be seen in **Table 2**, parents' pause durations in the predictive rhyme condition were more than two-and-a-half times longer than in the non-predictive rhyme condition, even though in both conditions the monster names themselves were not different in duration or emphasis, and despite no difference in the overall pacing of the stanza between conditions.

Finally, when we investigated whether parents' reading variables had any direct relationship with children's monster name retention, we found no significant correlations between any measures of parents' reading and the numbers of monsters correctly identified or produced by children. However, even though there was not a significant correlation between pause duration and correct monster identification overall ($r = 0.24$, $p = 0.22$, two-tailed) we wanted to look more closely at the subgroup of children who had heard pauses longer than 250 ms on average. Qualitatively, a pause shorter than 250 ms was imperceptible without sound-editing software. When we split children into two groups based on whether their parents' average pause length was greater than or less than 250 ms, there were 10 children who heard audible pauses before the monster names (all in the predictive rhyme condition), and notably, those 10 children showed a significant predictive rhyme advantage—this subgroup who had heard pauses greater than 250 ms had a mean difference score for correct identifications in the predictive rhyme condition minus the non-predictive rhyme condition of 0.80, significantly greater than 0, $t_{(9)} = 2.45$, $p < 0.05$; whereas those 18 children who did not hear an audible pause had an average difference score of 0.22, not different from 0, $t_{(17)} = 0.747$, $p = 0.47$. This meant that when children actually heard a pause before the novel monster

Table 3 | Parents' reading measures and children's performance by Condition in Experiment 2.

	Condition	
	Non-predictive rhyme mean 95% CI	**Predictive rhyme mean 95% CI**
PARENT MEASURES		
Pause duration (ms)	95 [27, 163]	249* [136, 361]
Target duration (ms)	754 [697, 812]	817 [759, 875]
Stanza duration (s)	12.7 [11.2, 14.2]	11.8 [11.1, 12.6]
Extra-textual utterances	4.0 [1.5, 6.5]	3.9 [1.2, 6.5]
CHILD MEASURES		
% Correct monster identifications	58 [49, 67]	72* [65, 80]
% Correct monster name productions	7 [3, 12]	11 [5, 16]

*CI, confidence interval. *$p < 0.01$ for difference between means of each condition.*

name they remembered almost one extra monster from the predictive rhyme condition compared to the non-predictive rhyme condition.

Discussion of experiment 2

With Experiment 2, we were able to see that it does indeed matter whether a novel word comes at the beginning or the end of a rhyming stanza for how well it can be remembered and learned. The main finding demonstrated that even when the same parents and children were reading a storybook, when the monster names came at the end of the stanza they were more memorable than when they came at the beginning. Monster names in both conditions received the support of rhyme, and even unique rhymed features that differentiated the monster, and monster names in both conditions received line-final prosodic emphases not differing in their durations. It appeared that *location* of the monster name within the stanza, on top of rhyme, distinguishing features and emphasis influenced differences in children's retention. Further, for those children whose parents paused just a quarter of a second or longer before reading the monster name in the predictive rhyme condition, there was an extra memory boost for those predictable monsters. We interpret this as a possible link between rhyme, predictability, and retention. For children who heard that little pause before the novel monster's name, there may have been an additive effect of time plus predictability, giving them an extra moment to anticipate the upcoming monster's name and an edge in remembering it a few minutes later.

GENERAL DISCUSSION

This study gave us a new view on the effect of rhyme on how well children can remember and learn novel words from stories. In Experiment 1 the differences found in monster name identification between the non-rhyme and the predictive rhyme conditions supported the few previous findings that rhyming words can make them more memorable for children (e.g., Hayes et al., 1982; Read and Macauley, submitted) showing that this is also the case for novel words that are rhymed with the features that help to distinguish them. Experiment 2 added to this finding by demonstrating that not only rhyming the novel words, but also placing them at the end of a stanza after the build-up of some anticipation was especially helpful.

Experiment 2 was also meant to be more natural for children, since their own parents read the stories with them. While the tasks were not directly comparable across the two experiments, we believe that children in Experiment 2 had more support with their parents present and reading to them, and that this may have encouraged a more comfortable storybook reading environment. For the purposes of this exploratory work, there was value-added in allowing parents to read the stories themselves free of constraints, in order for us to observe what techniques of reading parents spontaneously used with these rhymes. After all, it is that three-way interaction among parent, child, *and* book that enables word learning to occur. Of course now having seen how parents make use of strategic pauses in just the places we hypothesize may be helpful to young listeners, the next step of future research would be to empirically test the effects of deliberate pausing (or lack thereof) in a more controlled reading, such as that used in Experiment 1.

So, why does putting the monster name at the end of a stanza really make a difference? In our view, it is not simply extra emphasis on new words at the end of the stanza since line-final *and* stanza-final words were emphasized and elongated, and not simply a recency effect since testing occurred after many monster names had been heard at the beginning or end of stanzas. Our hypothesis is that it is the build-up to those novel words, their extra predictability, which encourages more engagement with them on the part of the child. A child may not be able to predict the exact name of a new monster (or any novel word for that matter) upon the first reading of a story, but when the new name comes at the end of the stanza the child might better be able to anticipate that *something* is coming that will *sound like* the previous line-endings. That anticipation may encourage attention, even some active prediction, and certainly may make the new name "stickier" as it is heard. The novel word at the end of the stanza just fits, like the last piece put into a puzzle, and is therefore boosted by how much the child has anticipated it. It is important to note here that because we think the *anticipation* of the rhyme is what may increase attention and make the novel stanza-final words memorable, this begs the interesting empirical question of whether even if the rhyme scheme were broken and the monster name failed the rhyme, whether the child would still find it memorable (or even *more* memorable?). Certainly, learning can occur when what we predict turns out to be wrong (e.g., Ramscar et al., 2010).

In the current study we have begun an initial exploration of three factors—rhyme, placement, and pausing—on predictability and the impact predictability has on novel word retention. We have not, however, begun teasing each of these factors apart, but rather have compared conditions that afforded little predictability (the non-rhyme condition of Experiment 1) to those that accumulated predictability. Because of this we cannot necessarily compare the individual factors to one another or yet understand how they might be interacting. In the monster rhymes of this study, we gave children as many advantages as we could to support the challenging task of mapping so many novel items in such a short story. In addition to the sound of the monster names being predictable from the preceding rhymes, we also built in unique features of each monster that could help distinguish him and highlighted those with rhyme. This, in accord with the feature-label ordering found to be most helpful by Ramscar et al. (2010), added a second layer of predictability to the stanza-final monsters in the predictive rhyme conditions. In future research, it will be valuable to tease apart these sources of predictability to assess each one's unique contribution. However, we were encouraged by these initial results demonstrating that added predictability in general could benefit children's retention.

In any study of word retention we must also consider the different challenges of hearing a new word and being able to pick out a referent that goes with it (i.e., receptive vocabulary acquisition) and the often more difficult task of encountering a referent and being able to produce the new word (i.e., expressive vocabulary acquisition). In both Experiments 1 and 2, children found it very difficult to correctly produce the monster names themselves, averaging less than a single monster in any condition. Thus, their "learning" of the monster names as demonstrated by the identification task was certainly only

a quick mapping—just the beginning stage of really knowing any new word. The challenge children faced in the production task was not entirely surprising, as we already know that there are differences in how well children gain vocabulary receptively versus productively from storybooks (e.g., Senechal, 1997), and in the real-world of shared storybook reading parents usually repeat books (and the novel words within) many times before children add those words to their productive vocabularies (e.g., Snow and Goldfield, 1983; Horst, 2013). Thus, it would be a key next step to investigate how the advantage for predictably placed, rhymed, stanza-final, novel words would play out after multiple readings in which the child would not only begin to find the novel words more familiar but also increasingly predictable.

Additionally, what children, themselves, bring to the task of word learning from storybooks is also important to consider. While the age range of participants was wide in the two experiments presented here, age was not, in itself, a significant factor. Age may have played a marginal role in children's successes in the production task, but because scores were so low in that task—basically at floor, we would caution such an interpretation. Often age in such a wide span of children is a proxy for language ability, though since we were not able to test children's overall vocabulary comprehension or production abilities with standardized tests here, we cannot know whether the effects of rhyme, and rhyme placement might have differed for children with high versus low (relative to their age) language skill. However, this also would be an important next step for future research. Ideally, a more diverse sample with a wider range of language ability and familiarity with shared book reading in future research would allow us to assess how these factors influence children's ability to take advantage of the predictability of rhyme.

Finally, this work on rhyme may beg the question that some of our parent participants have asked—should all children's books rhyme? Or even, should all rhyming books place the novel vocabulary at the end of a stanza? The answer is of course, no—some books just don't lend themselves to rhyme, and there is much more to be learned from shared storybook reading besides new vocabulary. But, if the singular goal of a book or of a parent or teacher is to teach a few specific words it certainly wouldn't hurt. In the well-known Dr. Seuss classic *Did I ever tell you how lucky you are?* (Seuss, 1973) the following stanza describes a particularly unlucky young man:

> Suppose, just suppose, you were poor Herbie Hart,
> who has taken his Throm-dim-bu-lator apart!
> He *never* will get it together, I'm sure.
> He never will know if the Gick or the Goor
> fits into the Skrux or the Snux or the Snoor (p. 13).

Our findings in this study cannot speak to whether a child will sympathize with Herbie or find this funny, but they do predict that of all these nonsense words, *Snoor* should be best remembered, and *if* it were a real piece of equipment might then become the easiest to learn.

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APPENDIX

TEXT OF RHYMES USED IN EACH CONDITION OF EXPERIMENT 1 (TARGET WORDS IN BOLD)

Non-rhymes

Here's a **smooze** who likes to cook
and on his head is a useful hook
where he can keep his recipe book
so when he's hungry he just takes a look

Here's a **groze** you cannot lose
wherever he goes he leaves some clues
because he wears two huge red shoes
his footprints are always real big news

This smart **flar** always knows
when he's near a skunk or near a rose
because he has a giant nose
he sniffs when he comes and sniffs when he goes.

This **greers** can go very far
when he rides in his super car
he's faster than a shooting star
he's so quick he's hard to draw

This sweet **smai** has no fears
because he has perfect heart-shaped ears
and the nicest sounds are all he hears
this lovely monster always cheers

When this **flook** looks at the sky
he uses his one big bright eye
to see all the stars way up so high
and the airplanes going by

Non-predictive rhymes

This clever monster's called a **flook**
He really likes to bake and cook
and on his head is a useful hook
to help him find recipes in his book

This funny monster's called a **smooze**
He's someone you cannot lose
because he wears two huge red shoes
wherever he goes he leaves some clues

This sniffing monster's called a **groze**
And this guy, he always knows
when he's near a skunk or near a rose
because he has a giant nose

This speedy moster's called a **flar**
He can go so very far
when he rides in his super car
he's faster than a shooting star

This lovely monster's called a **greers**
He's super sweet and has no fears
because he has perfect heart-shaped ears
and the nicest sounds are all he hears

This dreamy monster's called a **smai**
When he looks up at the sky
He uses his one big bright eye
To see all the stars way up so high

Predictive rhymes

Here's a monster who likes to cook
and on his head is a useful hook
to help him find recipes in his book
this clever monster's called a **flook**

Here's a monster you cannot lose
because he wears two huge red shoes
wherever he goes he leaves some clues
this funny monster's called a **smooze**

This smart monster always knows
when he's near a skunk or near a rose
because he has a giant nose
this sniffing monster's called a **groze**

This monster can go very far
when he rides in his super car
he's faster than a shooting star
this speedy moster's called a **flar**

This sweet monster has no fears
because he has perfect heart-shaped ears
and the nicest sounds are all he hears
this lovely monster's called a **greers**

When this monster looks at the sky
He uses his one big bright eye
To see all the stars way up so high
This dreamy monster's called a smai

ADDITIONAL RHYMES USED IN EXPERIMENT 2

Non-predictive rhymes

This soaring monster's called a **trings**
Up in the air he smiles and sings
He flies so high with his famous wings
Maybe he can teach the birds some things

This daring monster's called a **traul**
This guy will not ever fall
He's balanced on his shiny ball
Up there he's feeling pretty tall

Predictive rhymes

Here's a monster who smiles and sings
And flies so high with his famous wings
Maybe he can teach the birds some things
This soaring monster's called a **trings**

This monster will not ever fall
He's balanced on his shiny ball
Up there he's feeling pretty tall
This daring monster's called a **traul**

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"I think I can": achievement-oriented themes in storybooks from Indonesia, Japan, and the United States

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The focus of the present study is on the ways in which storybooks communicate cultural ideals about achievement orientation, and in particular, the role of effort, perseverance, and hard work in fostering successful outcomes. Sixty preschool children's books from Indonesia, Japan, and the United States (20 from each country) were examined for the presence of achievement-oriented themes. These countries were chosen due to previously documented cultural differences in models of learning and individualist/collectivist tendencies that could have some bearing on achievement outcomes. Texts were assessed for (1) the frequency with which "challenge events" appeared in the narratives, (2) whether these events derived from sources internal or external to the main character, and (3) whether solutions relied on the main character individually or included the assistance of others. Results show that Japanese storybooks contained significantly more challenge events than Indonesian storybooks. Compared with Japanese storybooks, American storybooks tended to include a greater proportion of challenges derived from internal qualities of the main character as opposed to external factors. Compared with American storybooks, Japanese storybooks contained a significantly greater proportion of challenges that were solved with individual efforts as opposed to efforts involving the assistance of others. Findings from this study contribute to our understanding of how storybook contexts can provide a rich source of information for young children learning about culturally valued qualities and behaviors related to achievement.

Keywords: achievement, storybooks, preschoolers, culture, socialization, Japan, Indonesia

INTRODUCTION

The values and beliefs children bring to the school experience have important consequences for their success. For example, students who have *perceived control*—that is, they believe that they can influence success or failure in school, tend to achieve higher grades, primarily through their greater engagement with classroom activities (Skinner et al., 1990). Similarly, research shows that *self-efficacy*, the individual's belief in her or his capabilities to attain specific goals, plays a role in academic achievement (Bandura, 1997; Zimmerman, 2000). Still another line of research shows that students who hold *incremental* (or malleable) *theories* of their intelligence choose more effort-based strategies in response to classroom failures and obtain higher grades than students who believe intelligence is fixed (Elliot et al., 1999; Blackwell et al., 2007). Children show different profiles in their approach to challenging tasks as early as kindergarten, with some displaying the belief that success comes from trying hard, while others exhibit feelings of lack of control (Ziegert et al., 2001). Thus, in examining the factors that are related to high vs. low achievement in school, it is important to consider how children form beliefs about themselves as learners and to identify the ways in which children's experiences convey information about what it takes to be successful even before they enter the formal educational system.

The focus of the present study is on the ways in which storybooks communicate cultural ideals about achievement orientation, and in particular, the role of effort, perseverance, and hard work in fostering successful outcomes. These ideals take on special significance in light of accumulating evidence that self-regulation, delay of gratification, and persistence are among the strongest predictors of academic success as children progress through the educational system (Duckworth and Seligman, 2005; Duckworth et al., 2007).

Storybooks targeted for preschoolers can be viewed as cultural tools that contain a wealth of information about social norms, values, and personal traits that are desirable within societal groups. As Lamoreaux and Morling (2012) maintain, there is value in examining cultural products since they likely reflect the "psychologies of members of a cultural group." For example, storybooks for preschoolers have been identified as sources of information for children about the specific emotions that are valued in different cultures (Tsai et al., 2007), as well as the mental states that guide how children understand themselves and others (Dyer et al., 2000; Dyer-Seymour et al., 2004). In the case of understanding the development of achievement motivation and beliefs, it may be that the narratives children encounter in storybooks offer information about the ingredients for successful problem resolution, and especially the personal

qualities and behaviors that are linked to achieving some goal or objective successfully. That is, storybooks may be important complements to the messages children receive from caregivers and other sources about behaviors and beliefs necessary for success.

In the present study, 60 preschool children's books from Indonesia, Japan, and the United States (20 from each country) were examined for the presence of achievement-oriented themes. These countries were chosen due to observed cultural differences in models of learning and individualist/collectivist tendencies that could have some bearing on achievement outcomes. Previous research has pointed to the tendency for Japanese students to attribute success to hard work and failure to lack of effort, in contrast to Anglo American children, who attribute success to a range of factors including luck and ability along with effort (Holloway, 1988). Furthermore, such cross-cultural differences in beliefs about effort are enacted in divergent patterns of responses to failure. Heine et al. (2001) reported that Japanese students who failed a problem-solving task responded by persisting even more, in contrast to North American students, who were less likely to persevere. It is possible that parental values and parenting practices have an influence on these patterns in children's achievement beliefs. As Holloway et al. (1986) have reported, Japanese mothers see failures in children's performance as primarily due to lack of effort, whereas American mothers view children's failures as due to a mix of low effort and low ability. However, as important as they are, parental "inputs" about qualities related to achievement are likely to be only one force shaping children's notions about culturally-valued qualities of the self. Our intent was to examine how variations in cultural products such as storybooks may also play a part in this process.

There is little research on achievement beliefs among students in Indonesia. Liem and Nie (2008) found that secondary students in Indonesia tended to hold more performance-oriented than mastery-oriented goals, being more attuned to achieving externally determined goals in a way that is socially approved than to intrinsic motivations to learn when compared to Chinese students. When we consider Dweck's (1999) research on achievement motivation, the implication is that for these students, there might be less value placed on the role of effort. The inclusion of storybooks from Indonesia offers an opportunity to see how a community that shares an orientation to collectivism with Japan, but which may differ in other aspects concerning notions of the self that may be shared with the United States, portrays messages about achievement to young children. Heine (2001) suggests that many aspects of the East Asian self (Japan), characterized by collectivism, interdependence, and a focus in interpersonal harmony, can be understood as arising from principles of Confucianism. Since this tradition emphasizes the importance of changing the self in order to accommodate to the demands of the social world, the prominence of effort beliefs in Japan seems like a natural consequence. Indonesia is typically considered a collectivist society (Hofstede, 1991). However, its religious tradition is considerably different from other East Asian countries. While Confucianism is recognized as one of Indonesia's six official religions, less than 0.2% of the population now self-reports as belonging to this group (Sensus Penduduk, 2010). The implication is that perhaps beliefs about effort might take a different form in this country.

The storybooks we selected were intended to represent widely read classic and contemporary works targeted for preschool children ages 3–4 in Indonesia, Japan, and the United States. In analyzing the content of these storybooks, we conceptualized achievement themes as being manifest by narratives in which the principal character encountered challenges or obstacles that had to be overcome. Texts were assessed for the frequency with which "challenge events" appeared in the narratives, the idea being that repeated attempts to solve a given problem or successive problems provided a message about the importance of effort, perseverance, and trying again without giving up. In an attempt to capture cultural variations concerning individual vs. collectivist themes, we also assessed whether these challenge events derived from sources internal or external to the main character, and whether solutions to challenge events relied on the individual actions or resources of the main character or whether the main character benefited from the assistance of others.

MATERIALS AND METHODS

A sample of 60 narrative storybooks from the United States, Japan, and Indonesia (20 per country) targeted for 3- to 4-year-olds was included in the study (see Supplemental Material for a complete list). Books from the United States and Japan were chosen using guidelines from previous research by Dyer et al. (2000); Dyer-Seymour et al. (2004). These books were selected from a larger database of approximately 190 children's storybooks compiled by Japanese experts and over 350 books compiled by American experts. These books were frequently read to young children and deemed appropriate for 3- to 4-year-olds based on the researchers' consultations of guidebooks for Japanese and American parents (Dyer-Seymour et al., 2004). Given a lack of comparable guidelines in Indonesia, the Indonesian storybooks were selected through teacher recommendations from 7 preschools and kindergartens in three cities in Central Java: Yogyakarta, Muntilan, and Semarang. We then equated the reading level of these books by computing the word density (number of words per page) of each American book and choosing 20 Indonesian books with comparable density.

CODING

All of the storybooks in the study sample were written in the original languages (English for books from the United States, Japanese for books from Japan, and Indonesian for books from Indonesia). In order to avoid confounds involving the coders' native language, their countries of origin, and personal values regarding effort and achievement, we decided to have the books from Japan and Indonesia translated into English and have a single, native English-speaking coder (who was blind to our hypotheses) complete the coding of all books. The translators were Japanese-English and Indonesian-English bilingual speakers who were also blind to the study hypotheses.

In each storybook, our analysis focused on the main character, which was determined by several criteria. First, the main character is usually stated in the title (e.g., "the Runaway Bunny"). Second,

the main character is mentioned or described more than other characters in the book. Third, the main "character" could be considered to be more than one individual (e.g., a team or pair of individuals), but only when there is no more detailed description of one character over another, or no one individual is mentioned more than another. Finally, the main character could be an entire group of individuals, as long as these individuals are mentioned as a unit.

Once the main character was established, we identified challenge episodes. A *challenge episode* is where the main character encounters an obstacle or difficulty that could prevent him/her from achieving a goal. We then coded each challenge episode along several dimensions. First, we determined the *source* of the challenge: Internal or External. An Internal source is where the challenge comes from some quality or behavior of the main character him/herself. For example, *Betsy stopped singing because she got sick; Michael decided not to join his friends on the basketball court because he believes he is too small*. An External source is when the challenge comes from the environment, a situation, or other characters outside of the main character. For example, *Betsy stopped singing because her parents didn't allow her to sing anymore; Michael didn't play basketball because someone took his ball*. Second, we identified the *solution* for the challenge: Individual or Social. An Individual solution is when the main character overcomes the challenge by her/himself. A Social solution is when the main character receives help from another character to overcome the challenge. Finally, at the end of each book, we determined whether the main character achieves his/her goal (Success or Failure). If the main character is successful, we also identified who gets the benefit of the solution in the end: only the main character (Individual benefit), an(other) character(s) (Other benefit), or both (Shared benefit). To assess the reliability of this coding, another native English-speaking coder (also blind to our hypotheses) scored a randomly selected set of 10 American storybooks in the sample. The inter-rater reliability between these coders was 0.78.

RESULTS

Based on the coding scheme described above, we analyzed the data by comparing the three countries in terms of the number of challenge events, the sources/types of challenges and their solutions, and the nature of the overall outcome.

BOOK LENGTHS

To examine whether the lengths of the books were equivalent for the three countries in the sample, we counted the total number of sentences for each book from Indonesia, Japan, and the United States. A One-Way ANOVA on this measure showed a significant effect of country, $F_{(2,\ 59)} = 7.324$, $p = 0.001$. *Post-hoc* analyses indicated that Japanese and American storybooks did not differ significantly from each other in length ($M_{\text{Japanese}} = 52.55$, $SD = 18.71$; M_{American}=56.2, $SD = 28.65$). However, Indonesian storybooks were significantly lower in length compared to storybooks from Japan and the United States ($M_{\text{Indonesian}} = 31.05$, $SD = 18.53$, $p = 0.010$, and $p = 0.002$, respectively).

NUMBER OF CHALLENGE EVENTS

For each book, we tallied the number of challenge events present in the textual information in the narratives. Most of the books in our sample included at least one challenge event (85% of the Indonesian books, 90% of the Japanese books, and 80% of the American books). A One-Way ANOVA conducted on the total number of challenge events as a function of country yielded a significant effect of country, $F_{(2,\ 59)} = 3.91$, $p = 0.026$. *Post-hoc* analyses showed that Japanese books had significantly more challenge events than Indonesian books ($M_{\text{Japanese}} = 4.75$, $SD = 2.49$; $M_{\text{Indonesian}} = 2.6$, $SD = 1.76$, $p = 0.035$) and that American books had a greater number of challenge events than Indonesian books, although the difference was only marginally significant ($M_{\text{American}} = 4.5$, $SD = 3.46$, $p = 0.07$). There was no significant difference in the mean number of challenge events for Japanese and American books.

These findings, of course, need to be tempered by the fact that book lengths for the Indonesian sample were shorter compared to Japan and the United States. There is less opportunity for challenge events to appear if books have less content. However, if the Indonesian books can be considered to represent the typical storybook experience for preschool children in that country, these data suggest that Indonesian children receive less exposure to characters that repeatedly attempt to overcome obstacles than children in Japan and the United States.

TYPES OF CHALLENGES AND SOLUTIONS

In order to obtain a better understanding of the types of challenges encountered by characters in the storybooks, we tallied the proportion of challenge events that were coded as Internal to the main character in their origin for each book. A One-Way ANOVA on this measure indicated a marginally significant effect of country, $F_{(2,\ 59)} = 2.52$, $p = 0.089$. American books depicted more Internal challenge events ($M = 0.45$, $SD = 0.42$) than Indonesian books ($M = 0.36$, $SD = 0.43$), which in turn depicted more Internal challenge events than Japanese books ($M = 0.18$, $SD = 0.27$). Further analysis showed that the contrast between means for American vs. Japanese books approached significance ($p = 0.079$).

In addition, the proportion of solutions to challenge events that were coded as Individual in nature was obtained for each book. A One-Way ANOVA on this measure showed a significant effect of country, $F_{(2,\ 59)} = 3.62$, $p = 0.033$. *Post-hoc* analyses showed that Japanese storybooks had a greater proportion of Individual solutions to problems compared to American books ($M_{\text{Japanese}} = 0.77$, $SD = 0.36$; $M_{\text{American}} = 0.44$, $SD = 0.43$, $p = 0.025$). The mean proportion of Individual solutions for Indonesian books ($M = 0.61$, $SD = 0.37$) was not significantly different from the two other groups.

OUTCOMES OF CHALLENGES

We hypothesized that collectivist vs. individualist themes might be revealed by the types of outcomes evidenced in the resolution of the overall dilemma or challenge presented in the narratives being examined. First, the overwhelming majority of books depicted successful resolution of the overall challenge depicted in the book. Only 2 or fewer out of the 20 books in

each country presented a failure to achieve success. For the successes, outcomes coded as having an Individual, Other-oriented, or Shared (between self and other) benefit were analyzed to see if patterns varied by country. A chi-square test showed no significant differences in how these outcome scores were distributed across the three countries, $\chi^2_{(4)} = 6.00$, $p = 0.199$. Most outcomes were directed toward the main characters themselves or shared between main characters and others. In no instance were others the sole beneficiaries of the problem resolution.

DISCUSSION

The current study examined storybooks targeted for preschoolers from Indonesia, Japan, and the United States for the presence of achievement-oriented themes. The books were analyzed in terms of the number of challenge events, the source of each challenge, and the type of solution for the challenge. The results revealed several interesting findings, as discussed below.

First, while Japanese storybooks were similar to American storybooks in the number of challenge events, these groups differed in terms of the source of the challenge and the solution for the challenge. The challenges depicted in American storybooks tended to be due to internal qualities of the main character, but the solutions for the challenge were mostly external in nature (i.e., the main character typically received help from others to overcome the challenge). The somewhat greater emphasis on internal sources of challenge in American storybooks is consistent with previous observations that American children tend to exhibit ability beliefs (vs. effort beliefs) (Holloway, 1988; Stevenson and Stigler, 1992). In contrast, challenge events in Japanese storybooks were mostly caused by external factors, but the solutions were mostly individual in nature. This emphasis on individual effort complements Heine et al.'s (2001) observations that Japanese students were more likely to persevere during challenging tasks compared to American students. Moreover, the Japanese storybooks' emphasis on individual solutions is particularly interesting when we consider the higher tendency for the challenge to be externally caused. It seems that in addition to effort and perseverance—values that have been observed in Japanese parenting (Holloway et al., 1986)—Japanese storybooks also convey a message of personal responsibility. That is, regardless of the source of the challenge, Japanese children are receiving the message to take "ownership" of the problem by exerting individual effort to find a solution. This pattern of findings is consistent with the idea that in Japanese society, notions of self are malleable and individuals are expected to focus on self-improvement (Heine et al., 2001).

Second, compared to the American and Japanese books, the Indonesian storybooks depicted the fewest number of challenge events. This pattern may indicate a smaller cultural emphasis on meeting and overcoming challenges. It also seems to complement previous observations that Indonesian students focus on externally defined performance goals instead of mastery goals (Liem and Nie, 2008), since mastery goals often require individual effort and perseverance. Of the challenge events analyzed, Indonesian storybooks fell in the middle between American and Japanese storybooks in terms of the source of the challenge (Internal vs. External) and the solution for the challenge (Individual vs. Social). This pattern of findings suggests that it might be premature or even inappropriate to make broad, sweeping assumptions about how achievement values align with collectivist vs. individualist tendencies. There may be more nuanced ways in which beliefs about effort interface with cultural values, whether collectivist or individualist, perhaps depending on other social forces such as religion, political history, or economic circumstances. Indeed, cultural orientation and achievement beliefs may even be orthogonal constructs. Certainly, these are rich areas for future research.

In conclusion, the present findings suggest that as cultural products, storybooks do seem to convey to young children some important, culturally valued messages about effort and achievement. Future work should examine whether and how values of effort and perseverance are conveyed in storybooks targeted for older age groups. As children get closer to formal schooling, do storybooks help prepare them by making these values more explicit compared to books for younger ages? It would be important to look for messages about schooling and in particular, whether schooling and its associated activities are described in terms of obligations ("work") or more enjoyable "opportunities to learn." More detailed analyses on the language by which these messages are framed could be informative.

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SUPPLEMENTARY MATERIAL

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Emotion displays in media: a comparison between American, Romanian, and Turkish children's storybooks

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Children's books may provide an important resource of culturally appropriate emotions. This study investigates emotion displays in children's storybooks for preschoolers from Romania, Turkey, and the US in order to analyze cultural norms of emotions. We derived some hypotheses by referring to cross-cultural studies about emotion and emotion socialization. For such media analyses, the frequency rate of certain emotion displays can be seen as an indicator for the salience of the specific emotion. We expected that all children's storybooks would highlight dominantly positive emotions and that US children's storybooks would display negative powerful emotions (e.g., anger) more often and negative powerless emotions (e.g., sadness) less often than Turkish and Romanian storybooks. We also predicted that the positive and negative powerful emotion expressions would be more intense in the US storybooks compared to the other storybooks. Finally, we expected that social context (ingroup/outgroup) may affect the intensity emotion displays more in Turkish and Romanian storybooks compared to US storybooks. Illustrations in 30 popular children's storybooks (10 for each cultural group) were coded. Results mostly confirmed the hypotheses but also pointed to differences between Romanian and Turkish storybooks. Overall, the study supports the conclusion that culture-specific emotion norms are reflected in media to which young children are exposed.

Keywords: emotion, children's storybooks, cross-cultural comparison, emotion norms, ingroup-outgroup comparison

INTRODUCTION

EMOTION DISPLAYS IN MEDIA: A COMPARISON BETWEEN ROMANIAN, TURKISH, AND EURO-AMERICAN CHILDREN'S STORYBOOKS

The study of emotion norms is important to better describe and explain cultural differences in emotion socialization. For example, experiencing positive emotions may be desirable universally. However, the quality of the experience may vary across cultures. Tsai (2007) demonstrated that Taiwanese Chinese rather prefer low-arousal positive emotions like contentment, whereas European Americans prefer high-arousal positive emotions like excitement; i.e., these two cultural groups differ in the desired (ideal) positive affect. This cultural difference in ideal positive affect was also reflected in children's storybooks of the two cultures (Tsai et al., 2007). These findings suggest that cultural artifacts, such as children's books, act as one of the specific pathways through which emotion norms are presented and can be culturally transmitted and learned. Therefore, children's storybooks may provide an important resource for children to learn about culturally appropriate emotions.

This study aims to analyze emotion norms as represented by emotion displays in children's storybooks for preschoolers and to expand the study of Tsai et al. (2007) in two ways. First, we aim to expand the cultural variation. Tsai et al. (2007) focused on the comparison of American and East Asian cultures, like many other studies. We aim to compare emotion displays in children's books from two Eastern European countries (Romania, Turkey) with books from the US. Second, Tsai et al. (2007) focused exclusively on the positive ideal affect. In the present study, we further include comparisons involving the displays of negative emotions as well as social context (ingroup/outgroup) in which emotion displays occur.

Studies about emotion norms are still scarce, but indirect evidence for potential cultural differences can be concluded from two different areas of research: (1) emotion display rules, emotion expression, and ideal affect that were studied in cross-cultural perspective over the last 10 years and, (2) studies about emotion socialization in different cultures that investigated parental beliefs about children's emotion competence. Both areas give some direct and indirect insight into cultural emotion norms.

GENERAL CULTURAL DIFFERENCES IN EMOTION EXPRESSION NORMS

Correlational studies analyzing the relations between emotion display rules and country characteristics showed that adults in more individualist countries endorse emotion expression overall more strongly than collectivistic countries (Matsumoto et al., 2008). The meta-analysis of emotion and culture by Van Hemert et al. (2007), which included 190 studies from 29 different countries, confirmed this result and also found that the same relation applies for the level of democracy and stability: countries with a higher level of democracy, higher observance of human rights and higher stability allow more emotion expression in general. The hypothesis that countries with higher uncertainty avoidance (i.e., societies with low tolerance for ambiguity and strict rules of belief and behavior; Hofstede, 2011) allow more negative emotion expressions could not be confirmed (Van Hemert et al., 2007).

Growing evidence with children also shows that school-aged children from East Asia (e.g., China, Korea), South Asia (e.g., Nepal, India), and the Middle East (e.g., Iran, Morocco) are less likely to be confrontational and more likely to hide their emotions, particularly anger, than children from the US or Western Europe (Cole et al., 2002; Novin et al., 2009, 2010, 2011; Wilson et al., 2012).

These differences in emotion expression at the country-level have typically been explained by differences in the self-construal dimension. The relative salience of the independent vs. interdependent self-construal has been conceptualized as playing a differential role in the organization of one's emotions, cognitions, and behaviors (Markus and Kitayama, 2010). Individuals in countries endorsing norms like individualism, equality, and autonomy show higher endorsement of independent self-construal, i.e., they perceive themselves as separate from others and unique, whereas individuals in countries endorsing collectivism, hierarchy, and embeddedness display higher interdependent self-construal, i.e., they perceive themselves as related to others.

The cultural emotion norms delineated in the adult emotion display rules literature are in line with emotion socialization studies in cross-cultural psychology. European American mothers elaborate and provide more detail when talking about emotions, and imbue their interactions with smiles and laughing to a greater extent than mothers from Japan, Indonesia, and China (see Fivush et al., 2006, and Tsai, 2007 for reviews). These findings imply that caregivers' culturally valued self-construal also acts to shape their emotion-related goals and socialization practices. In other words, emotion norms are learned and transmitted in line with the cultural models of emotion competence, defined as caregivers' expectations for children's understanding and expression of emotions. Research suggests that European-Americans favor an "individualistic" model of emotion competence, i.e., encouraging emotion expression in a more open way as parents strive to promote children's self-sufficiency, sense of autonomy and independence through creativity, assertiveness, and self-esteem (Greenfield et al., 2003). Consequently, self-expression and open communication of "ego-focused" emotions, such as anger, pride, and disgust, which support the assertion of the autonomous self are favored, while shame expression which may signal a threat to a child's self-esteem is discouraged (Markus and Kitayama, 2001).

Parents in collectivistic countries favor a relational model of emotion competence. In the relational model, proper behavior is prioritized into hierarchical relationships, such as respect for elders and loyalty to family, social harmony, and group interests (Matsumoto, 1991). Thus emotions that are ego-focused are considered potentially disrupting to interpersonal relations and are strictly controlled (Wang, 2003). In these societies, caregivers tend to promote emotion display rules which underscore the importance of interpersonal sensitivity and cultivate "other-focused" emotions like sympathy and shame in order to foster relational emotional competence (Chan et al., 2009).

CULTURAL DIFFERENCES IN EMOTION NORMS IN ROMANIA, TURKEY AND THE US

Most cross-cultural studies focus on US-Asian comparisons with an emphasis on cultural differences in individualism and collectivism, whereas East European countries were not often included in cross-cultural studies. Investigating East European countries can contribute to a better understanding of the variability within collectivist and group-oriented countries. East European countries like Turkey and Romania are less individualistic than US but also less collectivistic than East Asian countries like China or South Korea (Hofstede, 2001). Both countries have higher uncertainty avoidance, i.e., lower tolerance for ambiguity, than the US and East Asian countries (Hofstede, 2001). Romania and Turkey are qualified as countries that endorse the values of hierarchy (in opposition to egalitarianism) and embeddedness (in opposition to autonomy) in contrast to US (Schwartz, 2008). These similar value profiles make them also distinct from East Asian countries that endorse those values much more strongly.

Confirming these expectations, Turkish student samples did not endorse emotion expression as much as Americans did, but more compared to Hong Kong students in the emotion display rule studies mentioned above (Matsumoto et al., 2008). A qualitative cross-cultural study (Denham et al., 2004) about American, Romanian, and Japanese parents' strategies to manage their children's emotions highlighted Japanese parents' stress on restraining their preschoolers' emotion displays or downplaying their means of emotion expression in social situations. In contrast, Romanian parents did not mention such restrictions about emotion expression, and were similar to American parents' answers, but—in contrast to the American mothers—they were also eager to rather avoid the exposure of their child to negative emotions including showing their own negative emotion (e.g., anger; see also Bassett et al., unpublished manuscript). Finally, evidence from research that pertains to emotion socialization shows that Turkish mothers were more likely to make appeals to others' behavioral approval and feelings compared to US mothers in discipline contexts (Catay et al., 2008), pointing to Turkish mothers' efforts to cultivate relational emotion competence by prioritizing appropriate conduct and sensitivity to others' emotions. Altogether these studies support the general claim that emotion norms in Turkey and Romania are not identical with norms in East Asian countries, but they also diverge from American norms.

Romania is rarely included in multinational studies, but due to the common value orientations, we expect similarities in emotion

norms between these two countries. In light of limited recent research on emotion display rules and emotion-related parenting, and considering the common value orientations in Turkey and Romania (Kagitcibasi, 2007; Friedlmeier and Gavreliuc, 2013) that emphasize respect, self-restraint, and harmonious relations, we predicted higher intensity of overall emotion expressions in American storybooks compared to the Romanian and Turkish storybooks for preschoolers.

Cultural differences in emotion endorsement do not only refer to the intensity of the expression but also to the frequency of their display in the media. As this study investigates images in children's storybooks, an often repeated display of a distinct emotion can be interpreted as a salient feature of a specific culture. This means that this emotion is considered important and relevant, while a low rate of displays rather points to low desirability of such an emotion.

CULTURAL DIFFERENCES IN THE VALENCE OF EMOTIONS

Besides the generally stronger endorsement of emotion expression in the US, a differentiation along the valence of emotions is important as norms for positive and negative emotions may vary across cultures. Diener and Lucas (2004) analyzed the desired emotions for children by asking students in 48 different countries to rate the statement "I hope my daughter will be happy" on a 9-point scale from 1(*strongly disagree*) to 9 (*strongly agree*). Respondents in all countries desired high levels of happiness for their children. Happiness as desired for their children was more strongly endorsed by American than by Turkish students, but the difference was not significant (Diener and Lucas, 2004). This pattern suggests that adults in all cultures aim mostly to encourage positive emotions in young children (Cole and Tan, 2006). Therefore, we expected that children's storybooks from all three countries would show displays of positive emotions in a dominant way compared to negative emotions.

Despite the predominant display of positive emotions across cultural groups, the displays of positive emotions appear to differ in the intensity and activity level as a function of emotional norms in each culture. Tsai et al. (2007) compared the affective content of the best-selling storybooks in the US and Taiwan. Although the best-selling children's storybooks from the United States (US) and Taiwan did not differ in the number of pictures with positive affective states, books from the US contained significantly more pictures of characters depicted with excited expressions (i.e., wider smiles, laughing) than those in the Taiwanese storybooks. The emphasis of contentment and quiet activity may be less salient in Eastern European countries such as Romania and Turkey. However, based on the positive relation between individualism and expression norms for happiness (Matsumoto et al., 2008), strong positive expression may be more of a norm in the US compared to Turkey and Romania given the stronger collectivistic orientation of these countries. Hence, we expected a higher intensity of positive emotion displays in the American books compared to the Turkish and Romanian books.

Most studies to date treated negative emotions as a unitary construct without considering their valence (Van Hemert et al., 2007). In doing this, the researchers missed the point that there are two opposite classes of emotions within the negative emotions in regard to action readiness. Timmers et al. (1998) introduced the terms "powerless" and "powerful negative emotions" when studying gender differences in emotion expression, and Halberstadt (1986) called them "dominant" and "submissive negative emotions." Kitayama and colleagues have also made a differentiation between socially engaging and disengaging negative emotions based on the emotion themes grounded in independence or interdependence (Kitayama et al., 2006). Powerless negative, socially engaging, or submissive negative emotions, like sadness, fear, and shame, include the action readiness to withdraw, flee, or hide, and such emotions call for emotional support by others. Powerful negative, socially disengaging, or dominant negative emotions, like anger, jealousy, contempt, and frustration, include the action readiness to attack, to hurt, or to offend, and such emotions rather represent a threat to others. We will use the terms "powerful negative" and "powerless negative emotions" for this article.

These distinctions are being increasingly employed, and the differentiation between powerful and powerless negative emotions is essential for cultural comparisons (Kitayama et al., 2006). Emotions have both intra- and interpersonal meanings, which serve different functions in specific cultures (Matsumoto et al., 2008). Individualistic cultures place a higher emphasis on intrapersonal meanings, because they foster expressivity and place the individual at a higher level of importance compared to social relationships (Matsumoto et al., 2008). In collectivist cultures, powerless negative emotions are well accepted since they do not bring any harm to the group. However, powerful negative emotions are seen as disruptive and a threat to the group, and the need to suppress them is seen as much more important compared to individualistic cultures.

Supporting this view, Americans reported the intensity of experiencing powerful negative emotions (e.g., anger) as stronger than Japanese in response to negative events, while the reverse pattern was found for powerless negative emotions (Kitayama et al., 2006). In the study about desired emotions for their children, Diener and Lucas (2004) asked students in regard to anger ("I hope my daughter will not express anger, even when she has a reason for doing so"). Turkish students desired higher anger suppression for their children compared to American students.

Emotion socialization research also reveals that mothers from Turkey (Corapci, 2012; Corapci et al., 2012) and India (Raval and Martini, 2009) were more likely to encourage the expression of sadness compared to anger. Indian mothers also reported less scaffolding and more minimization for child anger than sadness (Raval and Martini, 2009). Unlike Indian caregivers, US caregivers were observed to give more attention to children's (4–6 years) anger than sadness and anxiety, reflecting differential parental socialization pressure to different child emotions (Chaplin et al., 2005).

Taken together, emerging research evidence supports the view that the expression of negative powerful emotions are encouraged more in individualistic cultures where relatively greater importance is placed on the independent self and the communication of self-focused; even interpersonally disengaging emotions is seen as a way to foster autonomy and assertiveness. Conversely, the experience and expression of negative powerless

emotions are discouraged in Western cultures, which may signal a threat to one's self-esteem. Therefore, we predicted that American children's storybooks would display powerful negative emotions more often and powerless negative emotions less often than the Turkish and Romanian books. These cultural differences in powerful and powerless negative emotions may not only have implications for the frequency of these displays in books but also to the presented intensity of the expressions. We expect that American storybooks will display a higher expression intensity for powerful negative expressions and lower intensity for negative powerless emotions than Turkish and Romanian books.

CULTURAL DIFFERENCES OF EMOTIONS AS A FUNCTION OF SOCIAL CONTEXT

Emotion norms not only vary across cultures in regard to the overall expression endorsement and the valence of the emotion but also as a function of social context. The emotion display rules study by Matsumoto et al. (2008) showed that members of individualist cultures endorsed stronger expression of negative emotions and weaker expression of positive emotions toward ingroup members (i.e., familiar social partners like family members and friends) compared to outgroup members (i.e., less familiar social partners like colleagues and acquaintances). The correlations were strong for negative powerful emotions (anger, contempt, disgust) and less strong but still significant for negative powerless emotions (sadness and fear). On the other hand, students in more collectivist countries endorsed that negative emotions, especially negative powerful emotions, should be expressed more intensely toward outgroup rather than ingroup members. Research with children also revealed that Indian, Korean, and Iranian children hide their anger more in the presence of their parents than their peers, while the reverse pattern has been documented for US and Dutch children (Raval et al., 2007; Novin et al., 2009, 2010). These findings fit with the values of collectivistic cultures, where an intense expression of negative powerful emotions toward ingroup members should be avoided strongly as group cohesion is threatened by this.

Collectivistic cultures also foster higher differentiation between ingroup and outgroup relationships compared to individualistic cultures (Triandis, 1995; Kashima and Kashima, 2003). A comparison of emotion display norms for negative powerful emotions between Canadian, American, and Japanese students confirmed this norm difference (Safdar et al., 2009). Japanese students showed the strongest distinction between ingroup and outgroup and evaluated it as more appropriate to express negative powerful emotions more intensely toward outgroup than toward ingroup members (Safdar et al., 2009). In light of research conducted with adults and children, we expected that the frequency and intensity of emotion expressions will differ more strongly for ingroup-outgroup contexts in Romanian and Turkish storybooks compared to American storybooks.

CODING OF EMOTIONS IN STORYBOOKS

Beside the theoretical framework, some methodological remarks are necessary as this study does not test individuals but refers to coding and analyzing illustrations of emotion expressions in children's storybooks. According to the Facial Action Coding System (FACS; Ekman and Friesen, 1978), emotion expressions can be analyzed as combinations of specific action units which refer to contractions of specific facial muscles (i.e., raised inner eyebrow, lips parted, nose wrinkled). Tsai et al. (2007) used part of this system to identify facial patterns of positive expression in storybooks. This analytical coding is considered a more objective measure compared to a synthesized decoding of an emotion that requests a synthesis of mimic (facial features), posture, gesture, causes, and context by the coder. However, the analytical approach is limited in several respects. First, the facial features of FACS are only determined for six distinct emotions (happiness, sadness, fear, anger, surprise, disgust), and do not include emotions like jealousy, shame, embarrassment, contempt, pride, and others. Second, the facial displays in the books are somewhat ambiguous as illustrators use different ways to draw the facial expressions. Additional information through gestures and postures can help determine the type of expressed emotion. Furthermore, illustrators from different cultures may use different features to determine emotion expression drawings. Cross-cultural research has shown that Japanese use the positions and form of the eyes to decode sadness and joy, whereas Americans focus on the mouth region, and this difference is also reflected in emoticons, combinations of keys that combine to form an approximate facial expression used in electronic communication (Yuki et al., 2005). Therefore, a synthesized judgment based on mimic, posture, gesture, and context about the emotion and the intensity of expression was chosen as a viable and appropriate way for coding these illustrations.

The analyses focus on the frequency rates as well as intensity of emotion expressions. As mentioned above, a frequent display of the same emotion can be interpreted as conveying high relevance of such emotion to the audience whereas the lack thereof may point to the fact that such an emotion is rather downplayed and seen as irrelevant.

HYPOTHESES

To summarize, this study aims to analyze the emotion norms by examining the images in storybooks for preschoolers from the US, Romania, and Turkey. Using the cultural models of self-construal (Markus and Kitayama, 2001) and emotion competence (Chan et al., 2009) as guiding theoretical frameworks and building on previous cross-cultural research on emotion display rules and emotion socialization, we predicted four main hypotheses:

(1) We expected that the storybooks from all three countries would display positive emotion displays to a greater extent than negative emotions.
(2) Negative emotion displays in American children's storybooks will represent a higher proportion of negative powerful and a lower proportion of negative powerless emotion expressions compared to Turkish and Romanian books.
(3) American children's storybooks will display higher intensity of expressivity for positive and powerful negative emotions compared to both Romanian and Turkish books. Due to the limited evidence, the examination of the cultural differences in negative powerless emotions is exploratory in the current study.

(4) Emotion expression frequency and intensity toward ingroup vs. outgroup members will differ more strongly in the Romanian and Turkish storybooks compared to American storybooks, particularly for powerful-negative emotions in the light of previous research.

METHODS

SELECTION OF BOOKS

We sampled 10 American[1], 10 Romanian and 10 Turkish children's storybooks for preschoolers or younger. Following the selection criteria used in previous research (Tsai et al., 2007), the most popular books in the U.S. were identified through online resources such as Amazon.com and through bookstores' bestseller lists in Turkey and Romania (see **Table 1**). The author and/or the illustrator are not necessarily members of the respective culture as some Turkish and Romanian books are translations from German or English books. Since these are best-selling storybooks, they are widely distributed and many young children are most likely to be exposed to these books. Beside popularity, the second selection criterion referred to the evaluation of the characters' emotion expression. Based on the most relevant mimic features according to Ekman et al. (1972), distinctive eyes, eyebrows, and mouth were necessary criteria. Books with animals as the main characters were acceptable as long as the facial features were human like enough to code. A third selection criterion was the requirement that the books had to have a storyline and a protagonist. This last criterion was deemed necessary because emotions are not static but rather dynamic; i.e., emotions (experience and expression) are evoked by a cause and also include action readiness to act upon the experienced emotion. Books with a storyline present emotions not just in static displays but give action-related information (e.g., cause of the emotion and action consequences) which convey information about emotions in a more vivid and accurate way. Taken together, these three selection criteria of (1) being widely distributed, (2) showing codable features, and (3) sharing a storyline served as basis of equivalence for all books.

PROCEDURE

First, the main coder (coder A) identified all codable characters in a book and numbered them to ensure that all raters would code the same images in each book. Only the characters in the story whose faces were fully displayed were coded. The images on the covers and title pages were not coded. Then each character was coded for identification of gender, social context, type of distinct emotion and intensity of expression.

All coders were trained and familiarized with the Facial Action Coding System (FACS) to apply an analytical approach for coding. They received some training faces to achieve high interrater agreement before they started coding. Two American coders were involved: Coder A coded all books, coder B coded all American books and the majority of Romanian and Turkish books. A Romanian coder (coder C) coded all Romanian books, and a Turkish coder (coder D) rated some of the Turkish books in order to control for cultural bias. This coding strategy ensured that three ratings were available for each book and one of the coders was a member of the respective cultural group. For data analysis, the majority code of the three was used to create the final data set. In the rare cases that the three coders showed three different codes, the final decision was made by a fourth coder.

MEASURES

Distinct emotion coding

Besides the facial expression of the character, the posture and gestures as well as contextual features like the description in the text or the drawn situation in the total picture allowed more reliable identification of the specific emotion. For this purpose, the Turkish and Romanian books were translated into English in order to facilitate the identification of the characters' distinct emotions. The American books were not translated as the Romanian and Turkish coders were fluent in English. The type of distinct emotion was coded as an overall evaluation of the displayed emotion by the rater, who considered facial expression and posture of a character and took into account contextual features including the text.

The list included 14 distinct emotions that were further classified into three types of emotions: *Positive emotions*, e.g., happiness, excitement, surprise, pride; *negative powerless emotions*, e.g., fear, sadness, embarrassment, shame, worry/anxiety; and *negative powerful emotions*, e.g., anger, disgust, dislike, contempt, jealousy. The interrater reliabilities for the emotion display variables across the four raters and the three countries were acceptable for the distinct emotion coding with a mean *Cohen's* $\kappa = 0.89$ ranging from 0.79 (rater A and D for Turkish books) to 0.96 (rater A and B for Romanian books). A frequency score was derived for each type of emotion based on the total number of counts across all books.

Intensity of expression coding

Intensity of the emotion expression was rated on a 4-point scale from 0—no expression, 1—weak expression, 2—medium expression, and 3—strong expression. The intraclass correlations for average measures across the respective three coders were 0.91 for American, 0.90 for Turkish, and 0.92 for Romanian books.

Social context coding

Social context code was differentiated into four categories. The protagonist was (1) with ingroup members, i.e., with familiar relatives (a parent, sibling or grandmother that lived in the house), best friend, teacher, significant other, (2) with outgroup members, i.e., with unfamiliar persons (e.g., strangers), (3) in a mixed group context, i.e., familiar and unfamiliar targets were present, or (4) alone. For hypothesis testing, only ingroup/outgroup context was analyzed. The alone context and mixed group were not considered further as no ingroup/outgroup distinctions can be made.

Each character was also coded for gender (male, female, or not known) and for representing the protagonist of the story (yes/no category). The interrater reliabilities for these variables were satisfactory with a mean $\kappa = 0.90$ for social context ranging from 0.84 (Rater B and Rater C for Turkish books) to 0.93 (Rater A and

[1]Different ethnic groups within US may favor different storybooks. Some popular Hispanic-American books are available in both languages (English and Spanish). Therefore, we decided to focus on European-American children's storybooks.

Table 1 | Book titles of the selected books.

Children's storybooks from		
US	**Turkey**	**Romania**
Alexander and the Terrible, Horrible, No good, Very Bad Day (2009)[a]	Ben Bir Ressamım! Dali (I am a painter! Dali) (2010)	Bobiţă şi Buburuză La Grădiniţă: Păianjenul din peşteră (Bobiţă and ladybug in kindergarden: spider from the cave (2012)[i]
Love you forever (2011)[b]	Hayvanları Çoook Seviyorum! Veli (I love animals! Veli) (2010)	Pupici pentru tatici (Kisses for daddies)(2008)[j]
I love You, Stinky face (1997)	Bir çizgi film Daha (One more cartoon) (2010)	Pinocchio (Pinocchio) (2011)[k]
The Potty Book for Girls (2000)	Değnek Adam (Stick man) (2008)[c]	Sora-cea-mica (Small sister) (2007)[l]
I'm a big Brother (1997)	Yavru Ahtapot Olmak Çok Zor (It is difficult to be a small octopus) (2011)[d]	Cenusareasa (Cinderella) (2009)[m]
Cloudy with a Chance of Meatballs (1978)	Sevim Ak Eskiler Alirim! (I buy old stuff!) (2007)	Gandaceii saritori (The jumping bugs) (2011)[n]
Max's Daddy goes to the hospital (1989)	Cemile oyuncaklarini paylasmak istemiyor (Camille does not want to lend her toys) (2006)[e]	Angelina şi Printesa (Angelina and the princess) (2006)[o]
No, David! (1998)	Ece ile Efe Hayvanat Bahcesinde (Zoe and Theo are in the zoo) (2008)[f]	Frumoasa şi Bestia (The beauty and the beast)(2011)[p]
David Goes to School (1999)	Atakan Cok Fazla Seker Yiyor (Atakan eats a lot of candy) (2007)[g]	Winnie de Pluş: De ce să dormi după-amiaza? (Winnie the Pooh and Friends: Why take a nap now?) (2011)[q]
Fancy Nancy (2006)	Zogi (A gold star for Zog) (2010)[h]	Alba –ca- Zapada (Snowhite) (2011)[r]

[a] Original published in 1972; [b] Canadian Book, Original published in 1986; [c] Original publish in English (UK; 2008); [d] First published in 2008; [e] Original published in French (2001); [f] Original published in French (2002); [g] Original published in French (2004); [h] Original published in English (UK; 2010); [i] Original published in Hungarian (2009); [j] Original published in English (Australia; 2005); [k] Original published in Italian (1883), adapted and translated in 2011; [l] Original published in English (2007); [m] Old European folk tale first published in French (1697); [n] Original published in English (Australia; 2011); [o] Original published in English (1984); [p] Original published in French (1740); adapted and translated into Romanian language by Disney Enterprise; [q] Original published in English (UK; 1926); [r] Old European folk tale first published in German (1812); adapted and translated in 2011.

Rater C for Turkish books) and a mean $\kappa = 0.98$ for gender and protagonist ranging from 0.98 to 1.00.

RESULTS

CULTURAL DIFFERENCES IN THE FEATURES OF THE STORYBOOK IMAGES

Preliminary analyses examined whether the American, Turkish, and Romanian storybook images were equivalent in terms of the quantity of images, the features of the characters and the contextual setting of the images. A total of 1118 images identified as fulfilling the criteria of fully displaying a character's facial and posture features were coded across the 30 storybooks. The number of coded images in Romanian books ($n = 430$) were significantly higher compared to the American books ($n = 318$), $\chi^2_{(1)} = 16.77$, $p < 0.001$ and Turkish books ($n = 370$), $\chi^2_{(1)} = 4.50$, $p = 0.033$, and the Turkish books had more figures than the American books, $\chi^2_{(1)} = 3.93$, $p = 0.047$. Since the number of the book pages did not vary across the three countries, $F_{(2,\ 27)} = 2.59$, $p = 0.094$, the higher numbers of overall images in the Romanian and Turkish books is due to the presence of more people displaying emotions in one scene.

The gender of the images did not vary significantly across cultures, $\chi^2_{(2)} = 4.03$, $p = 0.133$. The relative frequencies of displays in social contexts differed significantly across the three cultures, $\chi^2_{(6)} = 81.94$, $p < 0.001$ (see **Figure 1**). A main difference occurred for a direct comparison between ingroups and outgroups (by excluding mixed and alone): American books displayed emotions more in contexts with ingroup members, i.e., familiar persons (71.88%) compared to Romanian books (60.39%), $\chi^2_{(1)} = 17.50$, $p < 0.001$ and the Romanian proportion of displays to ingroup members was also significantly higher compared to the Turkish books (50.45%), $\chi^2_{(1)} = 16.66$, $p < 0.001$.

Many scenes in Turkish books represented a mixture of familiar and unfamiliar targets present at the same time (29.73%) which was significantly different from Romanian (9.53%), $\chi^2_{(1)} = 43.56$, $p < 0.001$, but not from the American books (17.30%), $\chi^2_{(1)} = 0.01$, $p = 0.957$. There was no cultural difference regarding displays in alone contexts, $\chi^2_{(2)} = 4.36$, $p = 0.113$, with an occurrence rate of about 10% (American books: 12.2%, Romanian books: 7.67%, and Turkish books: 9.73%; see **Figure 1**). No cultural differences occurred for protagonist, $\chi^2_{(2)} = 0.59$, $p = 0.746$: All books showed displays of the protagonist about 40% of the time, $\chi^2_{(2)} = 0.04$, $p = 0.812$.

DESCRIPTIVE RESULTS OF EMOTION DISPLAYS

The frequency distribution for different types of distinct emotions showed that among positive emotions, happiness was the dominant emotion in all three cultures (62.58%, $n = 649$) followed by surprise (7.52%, $n = 78$); interestingly, pride was rarely displayed (0.77%, $n = 8$) and never occurred in the Turkish books. Among negative powerless emotions, worry/anxiety was the most prevalent emotion in all three groups (12.25%, $n = 127$)

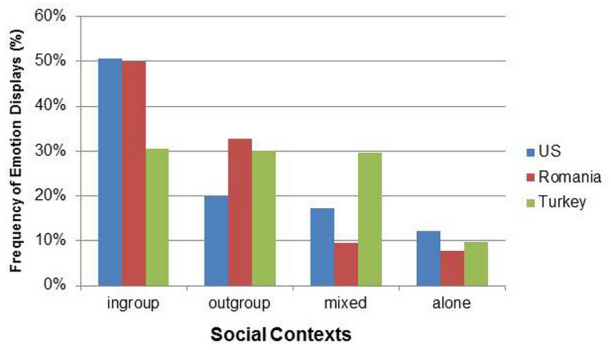

FIGURE 1 | Distribution of social contexts for the three cultural groups.

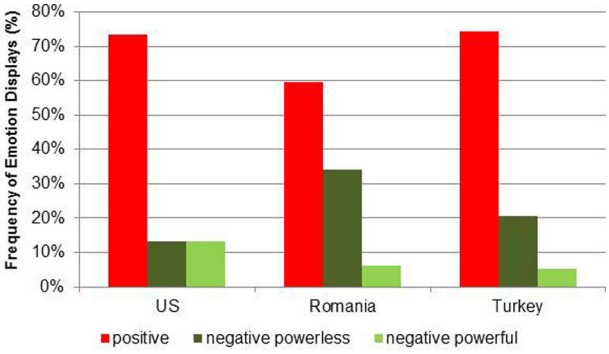

FIGURE 2 | Frequency rates of emotion displays in relation to cultural groups.

followed by sadness (5.98%, $n = 62$). Guilt was only displayed one time in Turkish and Romanian books and never in American books. Embarrassment was coded only in Romanian books (0.48%, $n = 5$). Among negative powerful emotions, anger occurred more often (5.59%, $n = 58$) in all three cultural books compared to disgust (0.58%, $n = 6$), which never showed up in the Turkish books. Contempt or jealousy did not occur at all in any of these storybooks.

HYPOTHESES TESTING

Emotion expression frequency

To determine cultural and contextual differences regarding the occurrence rates of emotions, loglinear analyses were computed. This statistical technique can be described as ANOVA for a categorical variable as dependent variable as it allows calculating the main effects and interaction effects of independent variables on the dependent variable. Specific group differences are computed as Maximum Likelihood chi-square tests. The unit of analysis is percentages of the three types of emotions (positive, negative powerless, and negative powerful emotions) across all books in each culture. First, we included gender as an independent variable. Since no interaction effects between gender and other independent variables occurred, we report the analyses without gender.

The overall loglinear analysis for positive and negative emotion displays by cultural group showed a significant effect for type of emotions, $\chi^2_{(1)} = 152.98$, $p < 0.001$. Compared to negative emotions, positive emotions were significantly more frequently represented in the books of all three cultural groups (about 69% positive and 31% negative emotions (see **Figure 1**), confirming hypothesis 1. However, there were also cultural differences regarding the frequencies of positive emotions, $\chi^2_{(2)} = 25.28$, $p < 0.001$. Romanian books displayed proportionally less positive emotions (59.53%) compared to American books (73.58%), $\chi^2_{(1)} = 4.07$, $p = 0.044$, and to Turkish books (74.32%), $\chi^2_{(1)} = 6.20$, $p < 0.013$. The percentage of positive emotions in the Turkish and American books did not differ, $\chi^2_{(1)} = 0.05$, $p = 0.826$ (see **Figure 2**).

The additional analysis within the negative emotions (powerful vs. powerless negative emotions) yielded strong significant cultural group differences, $\chi^2_{(2)} = 34.27$, $p < 0.001$. American books displayed negative powerless and negative powerful emotions equally (50% resp. 50%), whereas the Romanian and Turkish books had a significantly higher percentage of negative powerless compared to negative powerful emotions (Turkey: 80.00%; ML$\chi^{2(1)} = 13.89$, $p < 0.001$; Romania: 84.48%, ML $\chi^2_{(1)} = 31.63$, $p < 0.001$) (see **Figure 2**). The proportions of negative powerless and powerful emotions were similar for Romanian and Turkish books, ML$\chi^2_{(1)} = 3.628$, $p = 0.07$ (see **Figure 2**). These results confirm hypothesis 2.

Next, we explored the effects of social context on the occurrence of emotion displays. The loglinear analysis confirmed that the interaction effect for cultural group and social context was significant, LR$\chi^2_{(12)} = 40.93$, $p < 0.001$. We tested the interaction effect separately for each type of emotion.

Positive emotions were displayed more toward ingroup (77.19%) than outgroup members in the American books compared to the Romanian books (67.13%), $\chi^2_{(1)} = 17.56$, $p < 0.001$. Turkish books were more balanced in displaying positive emotions (ingroup: 47.80%, outgroup: 52.20%) than the Romanian books $\chi^2_{(1)} = 28.32$, $p < 0.001$ (see **Figure 3**).

For negative powerless emotions, all books displayed the emotion in a balanced way across ingroup and outgroup (US: 50.00%; Turkey: 49.09%; Romania: 52.07% for ingroup), ML$\chi^2_{(1)} = 0.15$, $p = 0.929$) (see **Figure 3**).

Negative powerful emotions were displayed more often to ingroup members (63.89%) than to outgroup members (36.11%) in the American books and more to outgroup members (63.16%) than ingroup members (36.84%) in Romanian books. Turkish books showed an unexpected pattern as all negative powerful emotions were displayed toward ingroup members. However, none of these comparisons was significant (overall LR-$\chi^2_{(2)} = 4.00$, $p = 0.135$), because the occurrence rate of negative powerful emotion displays was very low in these books: $n = 10$ in Turkish books, $n = 19$ in Romanian books, and $n = 36$ in American books (see **Figure 3**).

EMOTION EXPRESSION INTENSITY

To test hypotheses 3 and 4, we computed separate 3(culture) × 2(context) ANOVAs for each type of emotion (see **Table 2**). The ANOVA for positive emotions was significant with $r^2 = 0.088$. Positive emotions were expressed more

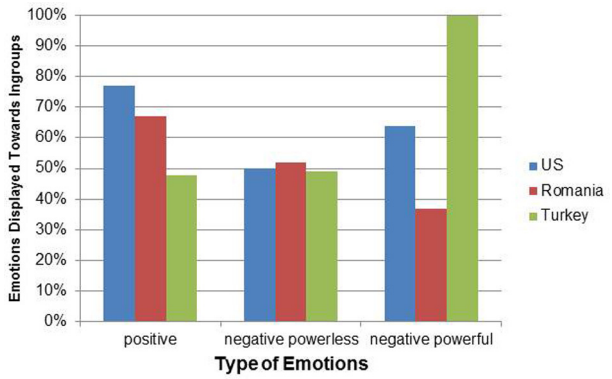

FIGURE 3 | Emotion displays toward ingroup members compared to outgroup members in relation to cultural groups and type of emotions.

strongly in American books ($M = 2.26$, $SD = 0.73$) compared to both Romanian ($M = 1.94$, $SD = 0.78$) and Turkish books ($M = 1.95$, $SD = 0.65$), $F_{(2, 531)} = 6.51$, $p = 0.002$. Furthermore, the context effect was only significant for the Turkish books, $F_{(1, 153)} = 35.33$, $p < 0.001$, and not for American, $F_{(1, 160)} = 0.85$, $p = 0.357$ and Romanian books, $F_{(1, 214)} = 0.02$, $p = 0.894$. In Turkish books, positive emotions were expressed more strongly to ingroup members ($M = 2.26$, $SD = 0.62$) than outgroup members ($M = 1.66$, $SD = 0.55$) (see **Table 2** and **Figure 4**).

For negative powerless emotions, the effect size was $r^2 = 0.154$. A similar cultural group effect as for positive emotions occurred, $F_{(2, 196)} = 3.96$, $p = 0.021$. Negative powerless emotions were expressed more strongly in the American books ($M = 2.46$, $SD = 0.71$) compared to the Romanian ($M = 2.12$, $SD = 0.76$) and Turkish books ($M = 2.02$, $SD = 0.59$). The context effect did not vary by country. Overall, negative powerless emotions were expressed more strongly toward ingroup members ($M = 2.37$, $SD = 0.58$) compared to outgroup members ($M = 1.90$, $SD = 0.78$), $F_{(1, 196)} = 11.63$, $p < 0.001$ (see **Figure 5**). No significant effects occurred for negative powerful emotions, $F_{(4, 60)} = 1.50$, $p = 0.214$, due to the low number of displays, especially in Romanian and Turkish books.

To summarize, hypothesis 3 was only confirmed for positive emotions. The hypothesis about ingroup/outgroup effects (hypothesis 4) with respect to emotion intensity was confirmed for American and Turkish books in regard to positive emotions but not for Romanian books.

DISCUSSION

This study aimed to investigate cultural differences of emotion displays in American, Turkish, and Romanian children's storybooks. In contrast to studies about emotion displays and emotion norms with participants, this study of fictitious displays in books allows analysis of frequencies as indicators for the importance of an emotion. Hence we expected that such media analysis would reflect commonalities and cultural differences in emotion norms between these different cultural groups. Going beyond the former studies that merely focused on positive emotions to investigate the cultural norms of emotion experience and expression in children's literature (Tsai, 2007), we investigated both positive and negative emotion displays in the storybooks. Based on the review of the current literature in this area, four hypotheses were formulated and tested.

DOMINANCE OF POSITIVE EMOTIONS

First, the expectation that positive emotions would be more frequently displayed in all children's storybooks compared to negative emotions (hypothesis 1) was confirmed. This result is in line with caregivers' desires to see the experience of positive emotions across many cultures (Diener and Lucas, 2004) and parents' general wish to evoke positive rather than negative emotions in young children (Cole and Tan, 2006).

CULTURAL PATTERNS FOR NORMS ABOUT NEGATIVE EMOTIONS

Our second goal was to investigate the cultural differences in regard to the frequency rate of negative displays. The hypothesis that American storybook characters would display more negative powerful and less negative powerless emotions compared to the characters in Turkish and Romanian storybooks was confirmed. The proportion of these two negative types of emotion was balanced in American storybooks. On the other hand, negative powerful emotions were displayed very infrequently in the Turkish and Romanian storybooks and the proportion of negative powerless displays were substantially higher than those in the American books. This result points to the importance of differentiating between types of negative emotions for cultural comparisons. Such a distinction was already effective for emotion studies of gender differences (Fischer and Manstead, 2000), and it may also be effective for cultural studies as interdependent cultures do restrict negative powerful emotions. An increasing number of emotion socialization studies have also begun to differentiate between specific types of negative emotions (US: Morris et al., 2011; Turkey: Corapci et al., 2012; India: Raval and Martini (2009); Nepal: Cole and Tan, 2006). These studies point to culturally distinct uses of emotion socialization practices in response to negative powerful emotions (e.g., anger) and powerless negative emotions (e.g., sadness; see Friedlmeier et al., 2011, in press). In general, the pattern of the findings from the current study is consistent with previous research such that negative powerful emotions are less acceptable in group-oriented cultures compared to negative powerless emotions because the former threaten the harmony while the latter elicit support, and these norms are also indicated in these storybooks. This pattern of findings supports the predictions drawn from the self-construal framework (Markus and Kitayama, 2010) and emotion competence models (Chan et al., 2009). The avoidance of displaying negative powerful emotions was especially obvious in Romanian storybooks as 15% of those displays even occurred when alone (while less than 1% in the American and Turkish books) and not in social situations. Overall, the display of negative powerful emotions was very low in the Romanian and Turkish books.

CULTURAL PATTERN OF EMOTION EXPRESSION INTENSITY

Our third goal was to investigate the cultural differences in emotion expression intensity. The hypothesis (3) that US children's

Table 2 | Effects of cultural group and social context on emotion expression intensity.

Culture	US		Romania		Turkey		*F*-values
Social context	In M (*SD*)	Out M (*SD*)	In M (*SD*)	Out M (*SD*)	In M (*SD*)	Out M (*SD*)	
Positive emotions	2.29^{a} (0.71)	2.16^{a} (0.80)	1.94^{b}(0.73)	1.93^{b} (0.88)	2.26^{a} (0.62)	1.66^{b} (0.55)	A: 6.51**, B: 13.31***, C: 7.80***
Negative powerless emotions	2.62^{a} (0.51)	2.31^{b} (0.85)	2.41^{a} (0.59)	1.81^{b} (0.80)	2.15^{a} (0.53)	1.89^{b} (0.63)	A: 3.96*, B: 11.63***, C: 1.48

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$. In: Ingroup members; Out: Outgroup members; A: Main effect "Cultural group"; B: Main effect "Social context"; C: Interaction effect "Cultural group x social context." Means with different superscripts differ significantly.

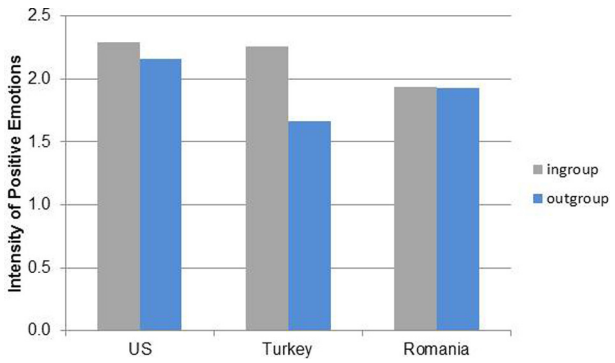

FIGURE 4 | Means of intensity of positive emotion expressions for cultural group and social context (ingroup/outgroup members).

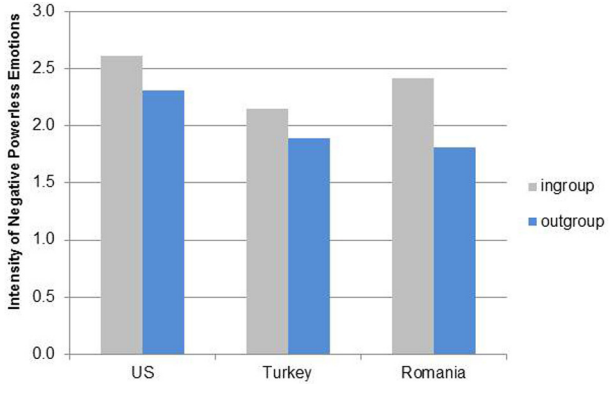

FIGURE 5 | Means of intensity of negative powerless emotion expressions for cultural group and social context (ingroup/outgroup members).

books would display higher intensity of positive and negative powerful emotion expressions compared to Romanian and Turkish books was confirmed partially. We found support for the expected cultural difference in positive emotion expressions but not for negative powerful emotion expressions. Furthermore, the assumption that the intensity of negative powerless emotion would be higher in Romanian and Turkish books than in American books was rejected. Contrary to our expectations, the intensity of negative powerless emotions showed the same cultural pattern as for positive emotions: American storybook characters displayed powerless emotions such as fear and sadness more intensely compared to the characters in Romanian and Turkish storybooks, although the frequency of powerless emotions was lower as reported above. Overall, the results of the present study rather point to stronger emotion expression regardless of emotion valence. The general higher expression intensity in American storybook characters is in line with cross-cultural differences reported in display rules and emotion expression studies with adult (Van Hemert et al., 2007; Matsumoto et al., 2008) and child participants (Cole et al., 2002; Novin et al., 2009; Wilson et al., 2012). The findings of the present study strengthen the assumption that the self-orientation in Western, individualistic cultures emphasizes open communication of emotions to support the assertion of self (e.g., Gottman et al., 1997). These emotions indicate inner states of autonomous individuals who rely on themselves to achieve goals and whose states are not readily understood by others without the individual's expressing them (Markus and Kitayama, 2001).

IMPACT OF SOCIAL CONTEXT ON EMOTION DISPLAYS

The fourth goal of the present study was to investigate the differential emotion expression frequency and intensity as a function of the social group. We expected higher ingroup-outgroup differentiation for the Romanian and Turkish storybooks compared to American storybooks. This hypothesis was confirmed for positive emotion intensity regarding the Turkish and American storybooks but not for the Romanian ones. As expected, the characters in the Turkish storybook pictures were depicted as showing positive emotions more intensely to ingroup compared to outgroup members, whereas American books did not make such a distinction. Unexpectedly, Romanian books were similar to the American books regarding the social context effect on the positive emotions. The hypothesis was only partly confirmed for frequency of negative powerful emotions. Negative powerful emotions were overwhelmingly displayed to outgroup members in Romanian compared to American books. This pattern fits with the norm to avoid displaying such emotions to ingroup members as such emotions threaten the group harmony. Opposite to the hypothesis, all negative powerful emotions of the Turkish books occurred in ingroup contexts.

Another interesting result pertained to the role of social context on negative powerless emotions. Specifically, emotions such as sadness and fear were displayed in higher intensity toward ingroup members in all three countries and were shown about

half of the time toward ingroup vs. outgroup members. The depiction of story characters as expressing powerless emotions more intensely to familiar relatives, best friends, or teachers rather than to strangers makes sense given the greater expectation of receiving emotional support and assistance from ingroup members. Our finding suggests that this expectation cuts across all cultural groups. This cultural similarity with respect to the ingroup-outgroup distinction also supports previous findings (Matsumoto et al., 2008) that in spite of a stronger norm of consistency Americans moderated and adapted the expression of negative emotions along contextual features.

DIFFERENT EMOTION NORMS IN ROMANIAN AND TURKISH BOOKS?

The results about the function of the context point to differences between Romanian and Turkish books. Either this difference refers to the lack of statistical power based on low frequency rates (e.g., low number of negative powerful emotions) or the emotion norms between Romania and Turkey are different. We assumed commonalities between Romanian and Turkish emotion norms. Although they share some norms and history, both countries differ in their political and economic development over the last 20 years. Since the breakdown of the communist system in the 90s, Romania became a democratic state, joined the EU, and started to be more oriented toward Western Europe in the last 10 years compared to Turkey. This was also noticeable in the fact that more of the popular Romanian books were translated books from Western countries compared to Turkish books. At the same time, Romania is still considered a rather traditional than a modern society according to value research like the European Value Survey (see M. Friedlmeier and Gavreliuc, 2013). Obedience and conformity are still important child-rearing goals, and these goals may keep alive the cultural norm to avoid strong emotion expressions, even negative powerless emotions, within the family. The analysis here suggests that negative emotions, especially negative powerful emotions, are less valued in Romanian compared to Turkish books. Most of the negative powerful emotions were displayed to outgroup members, and those emotions occurred also often when the protagonist was alone, which devalues such display toward others, especially familiar persons.

GENERAL CULTURAL FEATURES OF STORYBOOKS BEYOND EMOTIONS

This book analysis brought some interesting insights beyond the hypotheses testing: the books showed differences in some contextual features that can be interpreted as indicators for differences in general cultural norms. Romanian and Turkish books presented more group contexts, i.e., more figures showing emotions were displayed on average on one page. However, this difference was limited to the codable figures. We did not count figures that were also present but in the background (too small to code) or did not show any emotion expression. The emotion displays in the Romanian and Turkish books were presented more often toward outgroup members. The emphasis on (out) groups may indicate a stronger collectivist perspective, group-orientation, and interdependence model. The American books presented emotions mostly in private and familiar settings. These characteristics match well with the norms of individualism combined with family orientation which is characteristic for US culture (see Bellah et al., 1985).

EMOTIONS IN STORYBOOKS REFLECTING CULTURAL EMOTION NORMS

We selected the books by popularity. It is noteworthy to report that children's books with a storyline, many pictures of figures, and a low amount of text, may not be a universal feature in itself. When we started to look for children's books, we also looked into the option to have authors and illustrators from the same country. This search showed that such types of books are not common in Romania and Turkey. When we switched to the popularity criterion, we could find many translated books, mostly from English, French, or German. As these types of children's books were popular and became more popular over the last 10 years, this form of medium can be seen as a sign of cultural change in the Eastern European cultures. At the same time, such translated books sometimes can be an informative source about cultural differences, because the publisher may change the images in the books, and sometimes even the story changes.

Authors and illustrators of books have different intentions and may not consciously tell stories and present drawings based on culturally shared emotion norms. Nevertheless, we can assume that emotion norms are reflected in and transmitted through media like children's storybooks, and the results of this study underscore that culture-specific emotion norms regarding salience and intensity of emotion expressions can be found in such media. It was an interesting result that many self-conscious emotions like guilt, embarrassment, shame, and pride nearly did not show up at all and were represented at a very low level. Given the fact that these emotions develop in the preschool period (Lewis, 2008), book authors may assume that they cannot yet be grasped so easily by children, so they avoid exposing them to these types of emotions.

LIMITATIONS

A global rating of the emotion type and the intensity of expression was used to generate the main data for hypothesis testing. Similar to Tsai et al. (2007), we aimed to use FACS for coding emotion expressions. However, we met some limitations. Tsai et al. (2007) used FACS but they restricted the coding to limited features of positive emotions. As we expanded to negative emotions, the coding became more complicated. FACS is restricted to six basic emotions, and we aimed to include a wider range of emotions. Illustrators may not necessarily follow the emotion expression codes of FACS. Therefore, we decided to integrate the context information into coding of the type of emotion. The interrater agreement across coders form the different countries were satisfactory, but improvement of coding is desired for future studies. The results for the negative powerful emotions are limited due to the low number of occurrences, especially in Romanian and Turkish books. More books need to be coded to get more detailed insight into this type of emotion. Although the number of books was small, the number of coded images was rather high, and as we sampled the most popular books, we can assume that the audience of the books is widespread in the respective countries.

CONCLUSIONS AND OUTLOOK

This study shows that young children in Romania and Turkey are less exposed to intensive emotion expressions and they are less exposed to negative powerful emotions in popular children's storybooks. The media exposure for young children may occur when looking at those books on their own, but overwhelmingly they will experience these books through the presentation of a caregiver. Therefore, it is important to know how a parent reads to the child, i.e., how much they emphasize emotions and which ones. Some researchers investigated how mothers read wordless picture books and tell stories to young children, and cultural comparisons mostly refer to US-China comparisons (Doan and Wang, 2010; Tao et al., 2013). Early childhood teachers play also an important role (Denham and Bassett, 2012) for emotion socialization of young children, and no cultural comparison has been published so far. It remains a task for a future study to analyze how elaborately parents and teachers engage in the reading activity (i.e., the richness of detail they add to the story and pictures).

Knowledge about cultural difference in emotion norms is an important requisite to derive more precise hypotheses about cultural differences when studying emotion socialization with children and caregivers from a developmental perspective. Although such emotion norms are related to individualism/collectivism or independent/interdependent models of self (Markus and Kitayama, 2001; Tsai et al., 2006; Mesquita and Albert, 2007), they are not completely determined by such general norms. Insights into culturally shared emotion norms lead to better predictions of emotion socialization practices by caregivers for future cross-cultural developmental studies. For example, caregivers believing in the importance of strong excitement as ideal affect may encourage such expression of positive emotions in their children, whereas caregivers guided by contentment as ideal affect may even minimize the same displayed positive emotions of their children. Similar culture-specific emotion socialization strategies can be expected based on different norms regarding the negative emotions.

AUTHOR CONTRIBUTIONS

Wolfgang Friedlmeier and Briana Vander Wege started the idea for this project. Briana Vander Wege developed the coding system and coded all the variables for all books. Mayra L. Sánchez González contributed to the coding system and coded most of the variables for all books. Briana Vander Wege and Mayra L. Sánchez González wrote a first draft of the article that was then revised by Wolfgang Friedlmeier. Wolfgang Friedlmeier supervised the writing of the theoretical and method part, wrote the result and discussion section of the first draft and wrote the complete revised version. Linda M. Mihalca coded all Romanian and most of the American books and she contributed to later drafts of the article. Erica Goodrich was mostly responsible for data handling and data analysis and also contributed to later drafts of the manuscript. Feyza Corapci was responsible for the selection and coding of the Turkish books and contributed to later drafts.

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By the numbers: a quantitative content analysis of children's picturebooks

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Children's picturebooks are a distinctive art form and draw on a variety of storytelling and pictorial traditions; they are vibrant, everyday elements in the lives of many children. The dominant approach for researching picturebook content—stemming largely from the traditions in education and literary studies that have been most concerned with it—has been a qualitative one that focuses on detailed explorations of targeted books and a small number of children. This qualitative work has yielded (and continues to find) important insights. The current work, however, adopts a different approach and aims to a provide quantitative analysis of picturebooks.

A QUANTITATIVE DATABASE OF PICTUREBOOK CONTENT

Before arguing for the potential benefits of a quantitative approach, it is worth considering what such an approach looks like. Recently, my lab has been engaged in creating a quantitative database of picturebook content. The database is quantitative in two critical senses. First, it catalogs a reasonably large sample of books (we are starting with 100) that covers a somewhat representative sample of what children actually read. The sample includes books written since the year 2000 ($N = 56$) as well as older classics; Caldecott award winners ($N = 14$) as well as books connected to movies or TV shows ($N = 15$) and books suggested by parents in a survey ($N = 47$); narrative stories ($N = 89$) as well as thematic and ABC books; books explicitly marketed to infants 2-years of age and younger ($N = 27$) as well as books for toddlers ($N = 55$) and books aimed at older pre-schoolers ($N = 18$). The goal is to insure that the generalizations found in the sample accurately reflect the range of books available and of interest to children.

The second sense in which the database is quantitative is that the books are not only coded for categorical properties (e.g., Is the protagonist a child or an adult? What is the narrator's point of view and access to knowledge?) but in addition, every picture within each book is coded for its own properties (e.g., What character is in focus? How is the picture situated on the page?) as well as how it differs from the previous picture (e.g., Has the depicted location changed? Is the picture in the same artistic style?), and a complete hierarchical story-grammar is constructed for each book. The goal of this detailed coding is to allow for graded classifications of entire books as well as detailed examinations of within-book structure; each book can receive a quantitative profile that numerically summarizes how it embodies a range of elements. The full set of codes is compiled so that the information can be sorted and analyzed along any dimension that suggests itself as a fruitful research question. Moreover, the database is expandable and can incorporate new coding categories as needed.

USING QUANTITATIVE DATA FOR LITERARY ANALYSES

Conceptually, the idea of enumerating common story components as a means of understanding a genre goes back at least to Propp (1968). In his classic work, Propp identified a few dozen core narrative events that provided the structuring for (western) folk tales. Modern picturebooks are not folk tales, and may not constitute a single narrative genre. However, the database can help us identify common properties across the books, or at least, sub-sets of the books. Moreover, we can ask more quantitatively oriented questions, such as Which thematic features are most common across books? How many common components of story grammars do most books share? and How extensively do books make use of different narratological elements? These questions can help us create a nuanced taxonomy of this diverse set of books. For example, characterizing the protagonist is a core narratological function, but one that receives radically different treatment across our set of picturebooks. One measure of characterization depth is the number of pictures and pages that a book devotes to providing background information about the main character before a traditional narrative arc (organized around a conflict and resolution) begins. Our books range from providing 0 pages of character establishment (e.g., *Not a box*) to devoting more than 75% of the pages to character establishment (e.g., *No! David*). This difference has profound effects on the nature of the event structure of these books; for example, one consequence of devoting substantial space to character development, and consequently, less space to a conflict-resolution story arc, is that those arcs are not well elaborated, containing few episodes and very little sub-structure relative to books which devote less space to characterization. It appears there may be sub-genres of picturebooks that could potentially serve different functions for children.

More generally, the database can be used to evaluate theoretical claims about picturebook structure. For example, many researchers have argued strongly for the

role of inter-dependence between pictures and text in picturebooks (e.g., Sipe, 1998; Nikolajeva and Scott, 2001). The idea is that the pictures are not merely illustrations of the textual content but that the two work together synergistically to contribute to meaning-making in the stories. One way to quantify this idea was proposed by Martinez and Harmon (2012). They looked at different narrative functions such as setting, plot, and mood and asked whether the information was being conveyed through the pictures, the text, both independently, or both inter-dependently. Their work found that genuine instances of inter-dependence—where the pictures and text each contributed critical and non-identical information—were not dominant within the books, never reaching higher than 20% of the instances of a narrative function. Our coding uses similar categories to Martinez and Harmon, and preliminary analyses suggest that we are replicating their results with our larger sample.

Moreover, our coding schemes have also drawn on theoretical insights from analyses of comic books (McCloud, 1993; Cohn, 2010). For example, McCloud (1993) analyzes the transitions between panels in comics in terms of how space and time relations change and convey a sense of progress. He argues that most comics (particularly western ones) rely primarily on action-to-action transitions, although experimental and Japanese comics use a somewhat more diverse set of transition types. Our preliminary analyses of picturebooks suggest that despite their traditional and western origins, they may have more in common with experimental and Japanese comics. Like those latter kinds of comics, the picturebooks appear to contain a significant minority of moment-to-moment and scene-to-scene transitions across the pictures in addition to the more common action-to-action transitions. Further investigations will examine the extent to which different transition types are linked to different sub-types of books and different narrative functions. Moreover, anticipating the next section slightly, these transition patterns suggest experimental questions about how children's interpretations of different pictorial representations of time might be related to their developing understanding of temporal concepts in general, including their linguistic expression.

From a literary standpoint, therefore, the quantitative approach complements qualitative insights and allows us to capture how books are structured and related to each other in a systematic, detailed fashion.

PICTUREBOOKS AS INPUT FOR CHILDREN'S NARRATIVE KNOWLEDGE

Comprehension of narrative structure and the ability to re-create that structure when telling stories are important, advanced linguistic skills that continue to develop throughout the school-age years. The dominant approach to characterizing narrative competence comes from the story grammar tradition (but see (Nicolopoulou, 2008) for an alternative approach). Story grammars are hierarchal schematic representations of the story that capture basic narratological functions and are generally centered around the goal structure of the characters (e.g., Mandler and Johnson, 1977; Nezworski et al., 1982). Experimental work with adults and children has supported the idea that the grammars are psychologically valid: participants remember properly structured stories better (Mandler and Johnson, 1977) and can make explicit judgments about story organization that reflect story grammar elements (Gee and Grosjean, 1984; Mandler, 1987).

Studies with elementary school children have found that it is possible to improve children's understanding of story grammars by providing training on it. For example, Stevens et al. (2010) had kindergarten and first grade teachers use an interactive protocol that explicitly talked about story grammar elements during regular story-time periods (e.g., Who is the protagonist? What is the conflict?). Compared to a control group, the children who received this protocol could remember more about the stories they heard and their improved story comprehension extended to improved performance on a standardized reading test.

But even children who don't receive explicit training in story grammars still often come to understand and tell appropriate stories; most children implicitly learn about the underlying structures from the stories they hear. Indeed, children whose parents read to them more frequently show advantages in early language and literacy skills (Fletcher and Reese, 2005). Since what parents read to young children are often picturebooks, these books are one of the core input sources for children to learn about story structure from. Understanding which aspects of these books facilitate (or hinder) children's narrative understanding is useful for educators, and potentially, to authors themselves.

With the quantitative analysis of the books themselves, my lab is asking what information about story grammar is available for children to use: what components of story grammars are typically present and how much of each book is devoted to conveying the key story elements? Once these analyses are in place, we are positioned to ask how children themselves respond to different patterns in their input. For example, preliminary analyses of the story grammars of the sample have found that some books contain a very traditional narrative arc centered around a conflict and its resolution, and explicitly instantiate almost all the major elements of story grammars (e.g., *Caps for Sale)* while in other books, one or more major story grammar elements must be inferred (e.g., the primary central event of *Madeline*, the operation to remove her appendix, must be inferred from context) and other books simply lack a causal story arc altogether (e.g., *Maisy Goes to Preschool*). One might hypothesize that children at various levels of narrative competence would find these different types of books differentially engaging; further, one might predict that the books could be sequenced to provide optimal scaffolding for children's narrative development.

Another research question concerns how children make use of the picture and text information within a picturebook. Eye-tracking work by Justice et al. (2005) found that pre-school aged children devote nearly all of their attention to examining the pictures in picturebooks as opposed to looking at the text. This finding suggests the hypothesis that children will comprehend books better when the main story elements are conveyed through the pictures; or perhaps even within an individual book, children will comprehend those specific story elements

that are conveyed via pictures better than those conveyed via text. Moreover, the field of cognitive development offers an alternative suggestion for how children might make best use of picture-text relations. Studies investigating how children interpret gestures that accompany speech (Goldin-Meadow et al., 1993) have found that in many cases, children learn better when the two sources convey different pieces of information; that is, when there is a mis-match between gesture and speech. Pictures and text in picturebooks may operate in an analogous fashion and it is possible that mis-matches between the two—especially for a narrative element children are in the process of mastering—could constitute a critical scaffolding cue for improving narrative ability. Using the database, we can readily identify books that convey different story elements in different ways and select the critical cases to examine children's comprehension of story structure.

CONCLUSIONS

Picturebooks are a rich object of study in their own right and a fertile domain in which to identify specific hypotheses about what might drive children's narrative development. A detailed, quantitative analysis of these books not only allows for new insights into the structure of the books themselves, but it supports a range of specific hypotheses about how these books can influence children's ability to understand and tell good stories.

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When all children comprehend: increasing the external validity of narrative comprehension development research

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Narratives, also called stories, can be found in conversations, children's play interactions, reading material, and television programs. From infancy to adulthood, narrative comprehension processes interpret events and inform our understanding of physical and social environments. These processes have been extensively studied to ascertain the multifaceted nature of narrative comprehension. From this research we know that three overlapping processes (i.e., knowledge integration, goal structure understanding, and causal inference generation) proposed by the constructionist paradigm are necessary for narrative comprehension, narrative comprehension has a predictive relationship with children's later reading performance, and comprehension processes are generalizable to other contexts. Much of the previous research has emphasized internal and predictive validity; thus, limiting the generalizability of previous findings. We are concerned these limitations may be excluding underrepresented populations from benefits and implications identified by early comprehension processes research. This review identifies gaps in extant literature regarding external validity and argues for increased emphasis on externally valid research. We highlight limited research on narrative comprehension processes in children from low-income and minority populations, and argue for changes in comprehension assessments. Specifically, we argue both on- and off-line assessments should be used across various narrative types (e.g., picture books, televised narratives) with traditionally underserved and underrepresented populations. We propose increasing the generalizability of narrative comprehension processes research can inform persistent reading achievement gaps, and have practical implications for how children learn from narratives.

Keywords: narrative comprehension, development, knowledge integration, goal structure understanding, causal inferences, external validity, review

The human mind constantly interprets and learns new information from narratives, commonly referred to as stories. The majority of our conversations, media, and early educational resources occur as narrative discourse (Graesser et al., 1991, 1997, 2002b; Tannock et al., 1993; Trabasso, 1994; Berger, 1997; Trabasso and Stein, 1997; Pearce, 2003; Cevasco and van den Broek, 2008). Narratives are typically stories that contain characters, their goals, and successive events leading to accomplishment of goals (Trabasso, 1994; Eaton et al., 1999; Magliano and Radvansky, 2001). Narratives are often experienced as aural presentations (e.g., verbal stories), wordless picture sequences (e.g., young children's picture books), audio-visual films (e.g., movies), and written text (Trabasso et al., 1992; Berman and Slobin, 1994; Graesser et al., 2003; Paris and Paris, 2003; Berman, 2004; Kendeou et al., 2005, 2008; Verhallen et al., 2006). Research suggests that all narrative forms require similar underlying processes for comprehension (Trabasso and Nickels, 1992; Eaton et al., 1999; Graesser et al., 2002a; Paris and Paris, 2003; Kendeou et al., 2005, 2008; Florit et al., 2011).

Precursors to narrative comprehension processes emerge during infancy (Bauer and Shore, 1987; Bauer, 1992; Wenner and Bauer, 1999; Henderson and Woodward, 2011; Gerson and Woodward, 2012) and improve with narrative exposure, familiarity, and adult support (Morrow, 1985; Bauer and Shore, 1987; Berman, 1995; Whitehurst and Lonigan, 1998). These processes help children interpret external information to understand physical and social environments (Bauer, 1992; Berger, 1997) and encourage later school-related skills (Brown et al., 1986, 2011; Bauer et al., 1999; Paris and Paris, 2003; Pelletier and Astington, 2004; Kendeou et al., 2005, 2008; van den Broek et al., 2005; Zucker et al., 2010). Studies have even suggested a connection between narrative exposure and vocabulary development (Trostle and Hicks, 1998; Whitehurst and Lonigan, 1998; Brown et al., 2011; see Lynch et al., 2008 for a different perspective). Potential benefits of narrative exposure have inspired many researchers to explore the multifaceted nature of narrative comprehension. These explorations, however, have been limited by their emphasis on internal and predictive validity rather than external validity and generalizability.

This review addresses the external validity of research on narrative comprehension development as described by the constructionist paradigm (Graesser et al., 1994). First, we describe the constructionist paradigm's perspective on narrative comprehension, which argues that comprehension processes are employed to construct meaningful mental representations of narratives. Second, we review literature on the development of narrative

comprehension processes from infancy into adulthood. We identify gaps in this research for specific populations and ages. Third, we compare and discuss on-line and off-line assessments of narrative comprehension processes and propose a multi-method approach for developmental studies. Last, we argue that future research must incorporate methodology and scope that intentionally assesses narrative comprehension across diverse populations, knowledgebases, and media. Empirically informing our understanding of the generalizability of comprehension processes development will guide researchers to more accurately assess children and narrative media in the future.

NARRATIVE COMPREHENSION: THE CONSTRUCTIONIST PARADIGM

The constructionist paradigm defines narrative comprehension as a coherent understanding resulting from overlapping processes to form a comprehender's mental representation (Graesser et al., 1994, 1997, 2002a; van den Broek et al., 1996, 2005; Graesser and Wiemer-Hastings, 1999). Asserting that comprehenders "search after meaning" within narratives, Graesser and colleagues identified integration of prior knowledge (Graesser et al., 1997, 2003; Best et al., 2008), goal structure understanding (Graesser et al., 1994), and generation of causal inferences (Trabasso and Nickels, 1992) as overlapping processes that assist the maintenance of relevant story details in memory (Trabasso et al., 1989; Bower and Morrow, 1990; Zwaan et al., 1995a; Zwaan and Radvansky, 1998; Kurby and Zacks, 2012). Comprehension successfully occurs when these processes converge as a meaningful and coherent mental representation (Kintsch, 1988; van den Broek et al., 2005).

Other theories include processes described by the constructionist paradigm (e.g., inference generation, the integration of prior knowledge); however, they typically emphasize a more narrowed approach and would benefit from an increased focus on external validity and generalizability (e.g., Kintsch, 1988; McKoon and Ratcliff, 1992). The holistic view proposed by the constructionist paradigm emphasizes relations between processes and can be developmentally examined. Although developmental research on narrative comprehension and narrative production are clearly different, these differences are not always made explicit in the literature. For example, storytelling procedures can assess both comprehension and production abilities. It is the method of analyzing these storytelling procedures which clarifies the distinction. Studies of production are often interested in children's or adults' narrative quality, length, details, and cohesion (Berman, 1988, 2004; Shapiro and Hudson, 1991; Berman and Slobin, 1994; Peterson and McCabe, 1994; Wigglesworth, 1997; Peterson et al., 1999; Kulkofsky et al., 2008; McCabe et al., 2008; Curenton, 2010), whereas studies of comprehension examine mechanisms underlying the construction of narrative mental representations (Paris and Paris, 2003). This review identifies trends in the comprehension research field and describes them in **Table 1** (i.e., processes investigated according to population demographics). These trends reveal external validity concerns of population exclusion in comprehension development research. We discuss each process's role in comprehension, beginning with the integration of prior knowledge.

KNOWLEDGEBASE INTEGRATION

The process of knowledge integration requires access to stores of generic world knowledge and personal experiences in order to build narrative mental representations (Gowie, 1973; Kintsch, 1988; Graesser et al., 1994, 1997, 2001, 2002a,b; Graesser and Wiemer-Hastings, 1999; Brandão and Oakhill, 2005; Gerrig, 2011). Prior knowledge compensates for gaps in narrative coherence or when information is ambiguous (McNamara and Kintsch, 1996; Graesser et al., 2001, 2002b) and allows for generation of inferences connecting prior knowledge to narrative information (Hannon and Daneman, 2001; McNamara and Kendeou, 2011). Knowledge integration also allows comprehenders to update mental representations based on personal encounters and understandings (Long et al., 1989; Hamm and Hasher, 1992; Zwaan et al., 1995a; Prentice et al., 1997; Marmolejo-Ramos et al., 2009; Florit et al., 2011).

Narrative comprehension is vulnerable to deficits in prior knowledge (Graesser et al., 2003), particularly for children who have fewer world experiences (Graesser et al., 2002b). For example, consider the knowledgebase required to interpret a popular wordless picture book used to assess narrative comprehension processes in young children, *Frog, Where are You?* (Mayer, 1969). This 25-page picture book begins with an illustration of a boy and a dog in a bedroom. Also in the bedroom, a frog is in a jar. The child comprehender must first have some prior knowledge of, or experience with, animals kept in jars as pets. This knowledge must then be incorporated with the illustration to inform that the frog is the boy's pet. If this specific narrative event is new to the child, it will be more cognitively demanding to generalize and integrate prior knowledge (Graesser and Wiemer-Hastings, 1999) and potentially lead to difficulties in establishing a coherent understanding (Graesser et al., 2002b; Best et al., 2008). When successful, child comprehenders relate their own experiences to narrative content and appropriately infer meaning (Cain et al., 2001). For example, the child may know people hug animals that are pets and, therefore, infer from a picture of the boy hugging a frog that the frog is a pet. A child's knowledge-based inference for this event can potentially deepen comprehension, if successful, or limit them to a surface understanding if inference-making abilities are limited (Graesser and Kreuz, 1993; Graesser et al., 1997, 2002b; Graesser and Wiemer-Hastings, 1999; McNamara and Kendeou, 2011).

Despite the significance of knowledge integration for comprehension (Graesser et al., 1994, 1997, 2002b), this process has been investigated the least, particularly in children from low-income households (see **Table 1**). Our review of the literature found no studies intentionally assessing knowledge integration in children from low-income households, regardless of age. As such, there is little evidence to suggest these children integrate knowledge differently than children from middle- and high-income families; however, there may be qualitative differences due to varying background knowledge (McLoyd, 2013). For example, children from low-income households may be less familiar with concepts in a story about a preparatory school and exhibit less understanding of the character's goals than children from middle- or high-income families. On the other hand, they may have greater knowledge related to stories where characters independently overcome

Table 1 | Numbers of sources describing narrative comprehension processes across populations from low- and middle- to high-income households.

SES × age	0–1 years	1–2 years	2–3 years	3–4 years	4–5 years	5–9 years	9–17 years
KNOWLEDGE INTEGRATION							
Middle- to high-income households	0	0	0	0	1	6	4
Low-income households	0	0	0	0	0	0	0
GOAL STRUCTURE UNDERSTANDING							
Middle- to high-income households	3	5	0	7	19	24	16
Low-income households	0	0	0	2	8	5	2
CAUSAL INFERENCE GENERATION							
Middle- to high-income households	3	5	1	3	13	19	11
Low-income households	0	0	1	1	5	2	2

This table uses 71 sources with child samples from this review that describe narrative comprehension processes across childhood. Sources observing multiple processes or children from a range of socioeconomic statuses were listed more than once to account for all populations represented. For a more detailed list of references, see Appendices A and B.

obstacles using their problem solving skills. Domain-specific knowledge studies (see Alexander et al., 1994 for a review), however, should not to be confused with investigating how generalized prior learning and experiences lead to inferences (Hannon and Daneman, 2001). The dearth of experimental manipulations of knowledge integration presents a significant gap in our knowledge of narrative comprehension. If converging research aims to provide a holistic view of children's comprehension, gaps surrounding this and other processes must be investigated across all populations.

GOAL STRUCTURE UNDERSTANDING

Since narratives and everyday experiences follow goal directed patterns of actions and events (Trabasso, 1994; Berger, 1997), understanding links between characters' motives and narrative events is essential for forming coherent mental representations of narratives (Trabasso et al., 1989; Graesser et al., 1994, 1997; Wenner, 2004; Trabasso and Wiley, 2005; Lynch and van den Broek, 2007). Fundamental elements of narrative goal structure are goals, attempts, and outcomes (Trabasso and Nickels, 1992; Trabasso et al., 1992; Suh and Trabasso, 1993; Trabasso and Rodkin, 1994; Trabasso and Wiley, 2005; Lynch and van den Broek, 2007). Goals are defined as a character's desires that motivate subsequent actions (e.g., the boy wanted to eat). Attempts are actions taken to achieve the character's goal (e.g., the boy made a sandwich). Results of attempts are labeled outcomes, which can be successful, unsuccessful, reinstated, or abandoned. The degree that goal structure elements are logically matched facilitates comprehension in both adults and children (Albrecht and Myers, 1995; Low and Durrkin, 1998; Milch-Reich et al., 1999; Poynor and Morris, 2003; Egidi and Gerrig, 2006; Pyykkönen and Järvikivi, 2012; Orrantia et al., 2014).

Goal structure understanding also typically requires comprehenders to hierarchically relate goal structure elements (Trabasso and Nickels, 1992; Graesser et al., 1994; Trabasso and Wiley, 2005; Lynch and van den Broek, 2007). An initiating event causes an unwanted change in state for the protagonist (Trabasso et al., 1989) and a superordinate or primary goal forms to drive the remainder of the narrative (Trabasso and Nickels, 1992). Other goals supporting superordinate goal attainment are labeled "subordinate" and represented at lower levels of the hierarchy (Suh and Trabasso, 1993; Singer et al., 1994; Trabasso and Wiley, 2005). Subordinate goals are established when preliminary steps are required before an attempt can be made at the superordinate goal or when an attempt at a superordinate goal fails (Suh and Trabasso, 1993; Trabasso and Wiley, 2005; van den Broek et al., 2005). In the wordless picture book *Frog, Where are You?* (Mayer, 1969), children must understand that the boy's main, or superordinate goal, is to find the frog. In order to do so, the boy must form a subordinate goal of looking in specific locations (e.g., his boot, outside, in the woods; Trabasso and Rodkin, 1994). When an attempt successfully accomplishes a subordinate goal, another attempt can be made at the superordinate goal.

There is considerable agreement that understanding goal structures is important for comprehending narratives (Poynor and Morris, 2003; Lynch and van den Broek, 2007) through the generation of more inferences (Omanson et al., 1978; Lutz and Radvansky, 1997), aiding in retention when narratives are relatively long (Wenner, 2004), and allowing comprehenders to detect problems, anticipate solutions, and predict outcomes (Trabasso and Nickels, 1992). Goal structure understanding also increases understanding of main ideas (van den Broek et al., 2003). Few studies have investigated the impact of variations in goal structures. Research regarding the role of characters' competing goals, abandoned goals (Lutz and Radvansky, 1997; Magliano and Radvansky, 2001; McFarlan and Brown, unpublished manuscript), subordinate goals of secondary characters (Magliano et al., 2005), and multiple superordinate goals (Magliano and Radvansky, 2001; Linderholm et al., 2004) on comprehension is limited. Trabasso et al.'s (1992) work suggests that variations in objects that are targets of characters' motivations are important. Specifically, the frequent presence of a character's goal object in narrative scenes facilitates comprehension and may remind the comprehender of connections between character goals, goal objects, and attempts. Investigating goal structure variations will improve our current understanding of comprehension development and how goal structure understanding relates to causal inference generation.

CAUSAL INFERENCE GENERATION

Causal inferences support knowledge integration and goal structure understanding by connecting time and place of actions, characters, character goals and motivations, internal states, and other narrative events (Trabasso et al., 1989; Suh and Trabasso, 1993; Trabasso and Suh, 1993; Graesser et al., 1994, 2001; Singer et al., 1994; Tompkins et al., 2013). Causal inferences fill narrative information gaps allowing comprehenders to integrate real-world knowledge with goal structure information (Trabasso et al., 1989; Graesser et al., 1994, 2001, 2002a; Tapiero et al., 2002), connect events across the goal structure (Trabasso et al., 1989; van den Broek, 1989; Trabasso and Nickels, 1992; Graesser et al., 1994; Zwaan and Radvansky, 1998; Tapiero et al., 2002; van den Broek et al., 2003; Brandão and Oakhill, 2005; Kendeou et al., 2008), and identify inconsistencies between narrative and mental representation (Long and Chong, 2001). In general, causal inferences promote recall (Trabasso et al., 1989; Bloom et al., 1990; McKoon and Ratcliff, 1992; Myers et al., 1994; Singer et al., 1994; Rizzella and O'Brien, 1996; van den Broek et al., 1996; Trabasso and Stein, 1997; Brownstein and Read, 2007) by organizing narrative events into causally related chains (Trabasso and van den Broek, 1985; Trabasso et al., 1989; Trabasso and Nickels, 1992; Myers et al., 1994; Singer et al., 1994; Wolman et al., 1997; Long and Chong, 2001; Tapiero et al., 2002).

Categorized by the logic and type of information connected, several taxonomies exist for describing causal inferences that assist the formation of coherent mental representations. One classification distinguishes local causal inferences that link proximal narrative content active in working memory (McKoon and Ratcliff, 1992; Graesser et al., 1994; Myers et al., 1994; Singer et al., 1994; Long and Chong, 2001; van den Broek et al., 2003) from global causal inferences that organize local narrative events into an established higher order (Myers et al., 1994; Singer et al., 1994; Long and Chong, 2001; Mason and Just, 2004; Brown et al., 2011). Another classification differentiates enabling, physical, motivational, and psychological inferences. Enabling inferences weakly relate narrative events by adding details and are considered least complex (Trabasso et al., 1989; Trabasso and Nickels, 1992). For example, "Max went up the stairs (antecedent). He heard a creaking noise (consequent)." Physical inferences establish physical causality between events and provide the strongest relations (Trabasso et al., 1989; Tapiero et al., 2002). For example, "The jar fell off the windowsill (antecedent). The jar shattered (consequent)." Motivational and psychological inferences are considered most complex (Trabasso et al., 1989). Motivational inferences connect characters' goals to narrative events (Trabasso and Nickels, 1992; Graesser et al., 1994). For example, "The boy wanted to catch the frog (antecedent). He chased after him (consequent)." Psychological inferences connect narrative events to characters' resulting internal states (i.e., emotions). For example, "The frog had gotten away (antecedent). The boy became very angry (consequent)." Although some inference types are more cognitively demanding than others, all ensure coherently organized mental representations form (Trabasso and Stein, 1997; Long and Chong, 2001; van den Broek et al., 2003).

While research has examined how inference generation relates to knowledge integration in the form of knowledge-based inferences (Nicholson and Imlach, 1981; Frank et al., 2003; Cain et al., 2004; Bowyer-Crane and Snowling, 2005; Shears et al., 2007), few studies examine this interaction in children (see **Table 1**). Some studies suggest knowledge of story structure, and from the narrative itself, inform knowledge-based inferences (Cain et al., 2001, 2004). Future research should intentionally examine knowledge that allows generation of these inferences in populations of young children (i.e., 1- to 4-year-olds). This would improve our estimation of children's understanding by distinguishing how cultural and developmental knowledge impacts inferences and comprehension.

SUMMARY

The constructionist approach to narrative comprehension has offered important information about processes underlying comprehension (Graesser et al., 1994, 1997; Kendeou et al., 2005, 2009) and has lead researchers to examine its application to describing development of narrative comprehension processes (e.g., Trabasso and Nickels, 1992; van den Broek et al., 2005; Lynch et al., 2008). In the next section, we review research on narrative comprehension development in young children and identify gaps in the extant literature.

NARRATIVE COMPREHENSION DEVELOPMENT

The last two decades have focused on applying the constructionist paradigm (Graesser et al., 1994) to children, non-readers, and reading achievement during school. Based on research with children from middle- and high-income households, we know that precursors to basic narrative comprehension processes emerge during infancy and reach mature levels around 9 years of age (Omanson et al., 1978; Bauer, 1992; Trabasso et al., 1992). As early as 8 months old, infants begin exhibiting immature causal inferences and goal structure understanding, such as sensitivity to causal structure and means-end (i.e., goal-attainment) problems in the real world (Sommerville and Woodward, 2005; Gerson and Woodward, 2012). By 20 months of age, children can generate enabling inferences and have limited recall of ordered events (Cohen et al., 1999; Wenner and Bauer, 1999). These studies of precursor processes support the constructionist paradigm's notion that, even in infancy, humans make sense of their world by searching for meaning (Franco, 1997).

Development of comprehension processes reaches a critical period between 3 and 5 years of age (Brown et al., 1986, 2011; Benson, 1997; Kendeou et al., 2005, 2008; van den Broek et al., 2005; Lynch et al., 2008; Tompkins et al., 2013). By the age of 3, children can occasionally generate inferences about causal relationships between isolated, physical objects when they encounter them in wordless picture narratives (Berman, 1988; Trabasso and Nickels, 1992; Trabasso et al., 1992; Brown et al., 2011). Children at this age rarely form coherent narrative representations (Berman, 1988) because they struggle to identify key goal structure elements (Trabasso and Nickels, 1992; Trabasso et al., 1992) and possess limited knowledge of the world (Kendeou et al., 2005). At 4 years old, children appear to be in developmental transition (Trabasso et al., 1992; Wenner, 2004). They become more sensitive to hierarchical goal structures and relations between events (Morrow, 1985; Trabasso and Nickels, 1992; Trabasso et al.,

1992; van den Broek et al., 1996; Kendeou et al., 2005; Lynch and van den Broek, 2007; Brown et al., 2011). On the other hand, 4-year-olds rely more on enabling and physical inferences and less on complex inferences (van den Broek et al., 2005). Around age 5, children begin to use more mature processes (Trabasso and Nickels, 1992; Trabasso et al., 1992; Brown et al., 2011) and produce more goal-directed mental representations (Trabasso et al., 1992; Berman and Slobin, 1994; Kendeou et al., 2008; Brown et al., unpublished manuscript). These children have memorable experiences to integrate with narrative content, which increases the number and complexity of generated inferences (Trabasso and Nickels, 1992; Eaton et al., 1999; van den Broek et al., 2005; Brown et al., 2011).

From age 6 onward, comprehension processes continue to refine until maturity. Six-year-olds show increased sensitivity to causal relations (Lynch et al., 2008) and make more on-line inferences referring to superordinate and subordinate goals (Lynch and van den Broek, 2007). By age 7, children integrate world-knowledge and potentially over-rely on it for inference-making while ignoring narrative details (Cain et al., 2001; Brandão and Oakhill, 2005). Eight-year-olds appear to be more sensitive to subordinate goals and outcomes, but struggle with superordinate goals (van den Broek et al., 2003). Sensitivities to goal structures and inferences occurring at age 9 result in comprehension processing patterns similar to adult comprehenders (Trabasso et al., 1992; Orrantia et al., 2014).

FUTURE RESEARCH DIRECTIONS

Our review of the literature has identified several important gaps in developmental research regarding narrative comprehension processes (see **Table 1**). One gap is research that intentionally assesses the process of knowledge integration in children. We assume children rely on this process as a component comprehension process (Pearson et al., 1979; Nicholson and Imlach, 1981; Fincher-Kiefer et al., 1988; Prentice et al., 1997; Cain et al., 2001), but there has been little effort devoted to describing its development. Additionally, few studies have examined goal structure understanding development in children younger than 4 years old (see **Table 1**). This gap is noteworthy given that children's narrative comprehension heavily depends on goal structure understanding (Low and Durrkin, 1998; Milch-Reich et al., 1999; Lynch and van den Broek, 2007; Pyykkönen and Järvikivi, 2012). Lastly, even less is known about early causal inference generation and goal structure understanding in children from low-income and minority populations. Curenton (2010) and Benson (1997) provide only limited information about causal inference generation and goal structure understanding in these populations of children. Research in this area has excluded populations struggling most in reading achievement outcomes (Federal Interagency Forum on Child and Family Statistics, 2013), and represents 74% of the lowest quartile on national reading assessments (NCES, 2011). Addressing these gaps will identify whether differences between populations exist and the responsible risk factors (e.g., socioeconomic status; McLoyd, 2013).

Underserved and underrepresented populations must be included in future examinations of how narrative variations inhibit or aid comprehension (e.g., Trabasso et al., 1992). van den Broek (1989) argued young children first make inferences between concrete events and are increasingly able to make inferences about abstract events as they age; however, no study has directly examined this or how children comprehend competing or abandoned goals in narratives. Investigating these variations, especially in children from low-income and minority households would extend our knowledge of comprehension, provide developmental standards for children's narratives, and set a more externally valid precedent for future research (Sue, 1999). The future and complexity of narrative research will also require a multi-method approach to assessing narrative comprehension processes.

NARRATIVE COMPREHENSION ASSESSMENTS

Narrative comprehension assessments typically belong to one of two categories: on-line and off-line (Berman, 1988; Trabasso and Nickels, 1992; Trabasso et al., 1992; Paris and Paris, 2003; Lynch and van den Broek, 2007). On-line assessments require responses be actively generated during narrative presentation whereas off-line assessments require reflective responses be generated after narrative presentation (Milch-Reich et al., 1999; Lynch and van den Broek, 2007). These categories of assessments provide different information about the multifaceted nature of comprehension.

ON-LINE ASSESSMENTS

On-line assessments measure what information is integrated into narrative mental representations in "real time" (Milch-Reich et al., 1999). As such, on-line assessments measure ongoing construction and maintenance of narrative mental representations (Renz et al., 2003). This type of assessment is often used with children because it requires less from their limited attentional resources (Milch-Reich et al., 1999; Lorch et al., 2010). Typical on-line assessments include think-aloud protocols, probe questions, and narrations (or storytelling).

Think-aloud protocols assess comprehension during narrative exposure by requiring on-going commentary indicating narrative understanding (Suh and Trabasso, 1993). Typically used for written text comprehension assessment in adults (Trabasso and Suh, 1993; Magliano et al., 1999; Kendeou et al., 2011), think-aloud protocols have informed how and when mental representations form and update (Graesser et al., 1997; Kurby and Zacks, 2012). When used with children as young as 6 years old, narrative events are presented as picture books and children describe the main character's thoughts (Lynch and van den Broek, 2007) or what is happening in the scene (Milch-Reich et al., 1999). Think-aloud protocols have the potential to assess how comprehension processes are developing online at different ages (Suh and Trabasso, 1993; Milch-Reich et al., 1999; Lynch and van den Broek, 2007). Nevertheless, this method must be adjusted to assess young children who have limited or developing expressive vocabularies (Lynch and van den Broek, 2007).

Probe questions are open-ended questions assessing comprehenders' current mental representation at a given point during narrative exposure (Lutz and Radvansky, 1997; Lorch et al., 2006). A probe question might ask a child, "Why is the boy mad at his parents?" Answering requires recalling narrative events and generating inferences. Responses are analyzed for accuracy and are

indicators of comprehension processes (e.g., goal-related inferences; Lynch and van den Broek, 2007). Probe questions are challenging for younger comprehenders as they interrupt and divert children's already limited attentional resources and may actually disrupt comprehension (van den Broek et al., 2001).

Story narration methods typically require comprehenders create an oral story based on picture sequences (Berman and Slobin, 1994; Berman, 1995, 2004). Story narrations are perhaps most often employed using wordless picture books when assessing comprehension processing in preschool children (Shapiro and Hudson, 1991; Trabasso and Nickels, 1992; Paris and Paris, 2003; Brown et al., 2011). Picture books are often used because the stationary images offer fewer distractions for child comprehenders (Pike et al., 2010). Arfé and Boscolo (2006) asked a sample of hearing and non-hearing children to write, rather than orally produce, a story based on the children's picture book *Frog, Where are You?* (Mayer, 1969). Resulting narrations are analyzed for words used (Berman, 1988; Pelletier and Astington, 2004), number of goal related inferences generated (Lynch and van den Broek, 2007), accuracy of identified goal structure elements (Pemberton and Watkins, 1987; Brown et al., unpublished manuscript), and frequency and complexity of causal inferences generated (Arfé and Boscolo, 2006; Brown et al., 2011). Narrations allow individual processes to be assessed in terms of maturation. Ideal narrations include purposeful organization of narrative events (i.e., goal structure understanding), causal inferences of varying complexity, and integration of world and narrative knowledge (Trabasso and Nickels, 1992; Trabasso et al., 1992).

Other measures such as brain imaging, eye tracking, and reading times have also been used to assess on-line processes. Event related potentials (ERPs) and eye tracking have been employed in examinations of knowledge integration (Cook and Myers, 2004; Ferretti et al., 2013; Filik and Leuthold, 2013). Specific brain areas have been identified as important for causal inference generation (Mason and Just, 2004). Orrantia et al. (2014) showed 11-year-olds were more efficient than 9-year-olds at connecting character goals with actions based on faster reading times (see also Albrecht and Myers, 1995). Other studies use reading times to compare the availability of neutral, completed or achieved, and failed goal information in memory (Lutz and Radvansky, 1997; Richards and Singer, 2001). Obviously, reading times are inappropriate for young non-readers; however, eye-tracking methods measuring looking times during picture book narrations may provide insight into processing that emerges prior to formal reading (Evans and Saint-Aubin, 2005). Although ERPs have assessed language development in young children (e.g., Friederici, 2005; see Kuhl, 2010), brain imaging has not been extended to investigations of on-line narrative comprehension processing in preschool-age children.

OFF-LINE ASSESSMENTS

Off-line assessments measure the outcome of processing and what information has been included in comprehenders' final mental representations (Milch-Reich et al., 1999; Lynch and van den Broek, 2007). Although these assessments may not be the most appropriate for young children (Gibbons et al., 1986; Tompkins et al., 2013), they identify specific narrative content that has been comprehended. Commonly used off-line assessments include free recall, narrative retellings, and cued recall.

Free recall tasks assess what content is encoded as most important and accessible in a narrative (Kendeou et al., 2005). Open-ended recall prompts often ask comprehenders to "tell what you can remember from the story." This method allows for large variations in responses and has been instrumental in identifying individual and developmental differences in recalled content (van den Broek et al., 1996; Lorch et al., 2010). Free recall has examined comprehension across different narratives media types (e.g., videos, written text, and aural stories; Kendeou et al., 2005, 2008), how much narrative information was remembered (Kendeou et al., 2008, 2009; Kim et al., 2008) and comprehenders' causal sensitivity (Tompkins et al., 2013). Because of demands placed on attention, memory and interest, simple free recall tasks are not as sensitive to young children's comprehension (Gibbons et al., 1986).

Narrative retellings, a form of free recall, are considered the most ideal off-line assessment for child populations, as they allow them to revisit their narrative experience (Morrow, 1985; Wenner, 2004). Retellings may take the form of a verbal story (Trabasso et al., 1992; Lorch et al., 2010) or physical enactment with or without props (Morrow, 1985; Wenner, 2004). Accuracy of children's retellings indicates their sensitivity to narrative goal structure and inferred event relations (Morrow, 1985). Murachver et al. (1996) found the use of props and characters while enacting the narrative increased children's comprehension of narrative events. They suggest actively involving children in the narrative may assist comprehension by highlighting goal and attempt relations (Murachver et al., 1996).

Compared to free recall, cued recall is useful for determining the most effective cues for retrieving information from mental representations (Paris et al., 1977). Lorch et al. (2006) used cued recall questions to assess children's comprehension of narrative events. They found children's accuracy was greatest for narrative events in causal chains. Unlike on-line probe questions, cued recall questions typically yield very literal, content-based answers when used with children (Lynch and van den Broek, 2007). However, Omanson et al. (1978) found increased inferential comprehension for 5- and 8-year-olds during cued recall when compared to free recall. Cued recall may encourage inferences through vague questions such as, "What made the boy leave his house?" or assess specific narrative understanding through more literal questioning, such as "Who was in the tree?" (Lorch et al., 1999a). These questions draw attention to central narrative details, encourage inference generation, and assist in young comprehenders' maintenance of information (Lorch et al., 1999a,b, 2000, 2004, 2006, 2010; Curenton, 2010). As considerable dialog between early childhood educators and their students already involves inferential questioning (Zucker et al., 2010), researchers have increasingly employed cued recall to assess narrative comprehension in school-age children.

COMPARING AND COMBINING ASSESSMENTS

Accurately assessing comprehension demands a multi-method approach be taken, particularly when assessing narrative comprehension processes in young children. Our previous descriptions

of on- and off-line assessments highlight knowledge added from each assessment and its developmental appropriateness. However, both on- and off-line assessments contain methodological aspects that limit their use in isolation.

Investigating young children's comprehension processes typically employs on-line comprehension measures (e.g., picture book narrations; Berman, 1988; Trabasso and Nickels, 1992; Trabasso et al., 1992; Paris and Paris, 2003; Lynch and van den Broek, 2007; Brown et al., 2011). Although efficient and frequently used, narrating picture books may underestimate children's competencies if used in isolation (Trabasso et al., 1992). Three- to 5-year-olds, for example, may not fully articulate their understanding due to immature expressive language (Berman, 1988, 2004; Shapiro and Hudson, 1991; Berman and Slobin, 1994; Wigglesworth, 1997; Pearce, 2003; Kulkofsky et al., 2008; Curenton, 2010) and would benefit from additional comprehension tasks. Similarly, young children require additional training procedures to complete think-aloud protocols (Lynch and van den Broek, 2007). Isolated assessments may be unable to differentiate between cognitive resources used for completing the task (e.g., vocabulary) and specific comprehension processes (e.g., causal inference generation). Graesser et al. (1997) further argue that some on-line assessments, such as reading times, may provide ambiguous evidence about processes involved.

Similarly, off-line measures should not be used in isolation with children who may not possess the cognitive maturity required to construct a complete representation. Specifically, young children's limited attentional and memory resources may negatively impact performance on off-line assessments (Lorch et al., 1999a,b, 2000, 2004, 2006, 2010; Milch-Reich et al., 1999). While some off-line assessments use support props or illustrations (Morrow, 1985; Murachver et al., 1996; Wenner, 2004), narratives unable to provide such accommodations risk children misunderstanding story content. Children's comprehension errors made during narrative exposure are not easily corrected after their mental representation is constructed (van den Broek et al., 2001). As comprehension processing development is central to children's reading outcomes (Benson, 1997; van den Broek et al., 2005; Lynch and van den Broek, 2007; Kendeou et al., 2008; Brown et al., 2011), measures with developmental limitations cannot be used in isolation. We propose on- and off-line measures used in conjunction may provide insight as to how children engage specific processes when forming coherent mental representations.

A limited set of studies underscores the significance of a multi-method approach to understanding narrative comprehension development. van den Broek et al. (2005) suggested cued recall, in addition to story narrations, may provide information regarding young children's narrative mental representations. An early study employing this multi-method approach measured comprehension using cued and free recall but did not find parallel comprehension increases for 5- and 8-year-olds (Omanson et al., 1978). However, more recent studies found 4- to 8-year-olds' inferences generated on-line during think-aloud protocols and story narration positively related to the amount of narrative information included in both free and cued recall (Lynch and van den Broek, 2007; Tompkins et al., 2013). This suggests specific method combinations may provide accurate depictions of children's mental representations. For example, Trabasso et al. (1992) used both story narrations and cued recall questions to assess children and found, when prompted by cued recall, increases in story comprehension.

A multi-method approach to narrative comprehension processes research also has the potential to address many of the gaps in the extant literature. One gap is the examination of comprehension processes across narrative media presentations (Kendeou et al., 2005, 2008). The constructionist paradigm (Graesser et al., 1994) asserts processing should be similar regardless of presentation, which limited research has confirmed. Another gap encompasses the development of knowledge integration. Research suggests combining on- and off-line measures is most informative for investigating knowledge integration with adults. Narvaez et al. (1999) found changes in comprehenders' purpose (i.e., entertainment vs. studying) led to differences in on-line processing measured by think-aloud protocols, but not in off-line processing measured by free recall. Specifically, comprehenders' were more likely to engage in knowledge integration when reading to study. Thus, comprehenders' intentions may impact knowledge integration during on-line comprehension, but not the final mental representation. This finding has implications for reading instruction. Through intentional selection of multi-method assessments that can address variations in individual knowledge, population-based differences, and narratives across media, the body of comprehension research will more accurately describe how processes develop in all children.

EXTERNAL VALIDITY AND NARRATIVE COMPREHENSION DEVELOPMENT RESEARCH

Review of the current literature suggests an emphasis on internal validity when assessing narrative comprehension development that has resulted in a de-emphasis on external validity (Anderson et al., 1999; Sue, 1999). Internal validity addresses whether the construct being measured (e.g., tiredness) causes a specific effect (e.g., crankiness); whereas external validity addresses whether a causal relationship can be generalized across other measures, populations, time, and settings (e.g., Does tiredness make all children cranky? Bracht and Glass, 1968; Calder et al., 1982). These validities have an inverse relationship, such that increasing experimental control (internal validity) decreases generalizability (external validity). Arguments against externally valid studies include the suggestion that such studies are nearly impossible to conduct (Calder et al., 1982; Mook, 1983) and that they decrease internal validity, which hinders progress of scientific research (Calder et al., 1982). Alternatively, it has been suggested that subtle, systemic biases have crafted contemporary psychology to value empiricism and internal validity, resulting in a lack of high quality ethnic minority research (Sue, 1999). Despite resistance to, and perceived difficulty of, conducting experiments that account for background factors affecting generalizability (Calder et al., 1982), externally valid research has been influential in identifying significant truths about how humans operate (Anderson et al., 1999; Quintana et al., 2006). For example, Paris and Paris (2003) assessed on- and off-line narrative comprehension in 158 racially and socioeconomically diverse 5- to 8-year-olds from the

same city. Despite having a representative sample, they reported finding only developmental and ability-related differences in children's comprehension rather than differences related to racial and socioeconomic factors. These results raise the empirical question of whether demographics systematically relate to narrative comprehension abilities (Sue, 1999; McLoyd, 2013). Addressing this requires first identifying if significant differences stem from race or socioeconomic status, and then under what circumstances those differences manifest. However, until greater research intentionally assesses diverse populations, we can only speculate differences in background knowledge may exist. Hence, we have highlighted external validity concerns in the extant literature and identified what may be gained by addressing these concerns. Specifically, we argue for more studies that account for individual knowledgebases, differences in populations, and narrative media types employed when assessing young children.

INDIVIDUAL KNOWLEDGEBASE

In order to broaden the scope of narrative comprehension research to include all children, researchers must proactively consider the impact of individual differences in knowledgebase on comprehension. It is understood that knowledge impacts mental representation formation (Myers et al., 1994; Singer et al., 1994; Zwaan et al., 1995a,b; Long and Chong, 2001; Brandão and Oakhill, 2005; Gerrig, 2011; Kurby and Zacks, 2012) and comprehension (Gowie, 1973; Graesser et al., 1994, 1997; Best et al., 2008); however, knowledgebase content is constrained by many external factors including age, gender, environment, geography, culture, race and ethnicity, and socioeconomic status. The problem arises when highly controlled experiments find deficits in children's comprehension processes that can be attributed to individual variations in knowledge. For example, a child from a metropolitan area may not have the necessary knowledge to integrate and comprehend why the boy would want to capture and bring home a frog in the picture book *Frog, Where are You?* (Mayer, 1969). Labeling such variations as merely individual differences (Hannon and Daneman, 2001) is problematic because it implies that a standard body of knowledge transcends all ages, cultures, and differences; and that any knowledge deviations are indications of cognitive deficits.

We must consider more directly then the impact of knowledgebase differences on narrative comprehension processes and their assessment (Graesser et al., 1997). When assessing different cohorts of children, Berman (2004) noted that the concept of a "birthday party" differed for American and Israeli preschoolers. For American children, a birthday party was typically an open-ended script. For Israeli preschoolers, however, it was associated with a highly conventionalized and stereotyped concept. This difference in knowledge may impact goal structure understanding, causal inference generation, and overall comprehension for narratives that include birthday party information.

Differences in experiences may affect what knowledge comprehenders integrate during comprehension (Berman and Slobin, 1994; Gorman et al., 2011). A robust literature describes the importance and frequency of storytelling interactions in African American and low-income families (Gardner-Neblett et al., 2012). There is some suggestion that African American children from low-income households may actually have unique strengths in narrative processing (Gardner-Neblett et al., 2012) because storytelling practices provide children with early exposure to narrative structure and rules (Sperry and Sperry, 1996). Indeed, Curenton (2010) found that, among samples from low-income families, African American children understood characters' goals more often than European American children.

Future comprehension research must select narrative stimuli, assessments, and study designs that account for knowledgebase. For example, Hannon and Daneman (2001) provided nonsense concepts that related to real-world images (e.g., a *MIRT* resembles an ostrich, but with a larger and longer neck), which measured whether participants had access to specific prior knowledge that impacted their inference making. Performance on this task accounted for much of the variance in reading comprehension, suggesting prior knowledge had a significant impact on comprehension. Assessing knowledge used during specific comprehension tasks can reduce biases in future research that may be due to environmental, economic, or cultural variations (see Sue, 1999; McLoyd, 2013). If researchers intend to close existing gaps in the literature, changes in experimental procedures must be made to account for variations in knowledgebase across diverse populations (Gorman et al., 2011).

DIVERSE POPULATIONS

By examining narrative comprehension development in diverse populations, researchers will better understand the development of fundamental comprehension processes. Much of the reviewed literature has indicated a trend for assessing convenient and relatively homogenous samples (Sue, 1999). In reality, many studies fail to specify the sample and population (e.g., Cain et al., 2004; Kendeou et al., 2008, 2009). This is detrimental in that much can be gained from examining how ordinary human variations impact comprehension processing. We have identified how diverse samples informed previous narrative comprehension research through differences in ability, culture, and environment; yet, a dearth of research directly tests the role of these factors.

Examining comprehension processes in populations with diverse cognitive abilities has enhanced our general understanding of resources necessary for comprehension. For example, numerous examinations of children with attention deficit hyperactivity disorder (ADHD) have advanced our appreciation for attentional resources needed for narrative comprehension and young comprehenders' limits (Tannock et al., 1993; Lorch et al., 1999a,b, 2000, 2004, 2006, 2010; Renz et al., 2003). One study examining children with mild mental retardation and learning disabilities found narrative recall was related to information on causal chains (Wolman et al., 1997). This confirmed that children's and adults' cognitive load is reduced when comprehending narratives that are highly causally-related (Trabasso and Sperry, 1985; Trabasso and van den Broek, 1985; van den Broek et al., 1996; Lorch et al., 2006). Similar to typically developing children (Kendeou et al., 2008), this sensitivity to causal structure has been found to develop relatively independently of basic language skills in young children with Down syndrome (Kim et al., 2008). Investigations of non-hearing (Arfé and Boscolo, 2006; Chamberlain and Mayberry, 2008) and non-seeing

(Carreiras and Alvarez, 1999) populations have demonstrated both similarities and differences in narrative comprehension processing. These studies speak to factors supporting the development of comprehension processes and highlight the necessity of examining populations typically underrepresented in research.

A greater concern regarding the current body of literature is the underrepresentation of racial and ethnic minority samples. Findings from predominately European American, middle-class populations may yield results with minimal variability and limited generalizability to other populations (Sue, 1999; Frierson et al., 2008). It is suggested that there are numerous concerns to be addressed when recruiting racial and ethnic minorities in research (Frierson et al., 2008). A limited number of studies have focused on traditionally underrepresented and underserved populations when examining narrative comprehension processes. (Melzi, 2000; Fiorentino and Howe, 2004; Curenton, 2010; Gorman et al., 2011; Brown et al., unpublished manuscript). Results from Gorman et al. (2011) identified cultural differences in storytelling style and how these differences impact comprehension. Latino children emphasized character names during storytelling, African American children included story embellishments, and European American children emphasized character relationships. While this procedure provided a culturally non-biased context for analyzing story production, a less culturally sensitive researcher might have concluded that some children struggled to identify and emphasize key story elements based on stylistic differences. It is imperative then that future studies consider the role of cultural values for future and past narrative research (Quintana et al., 2006).

Some research intentionally increases external validity by purposefully including children from low-income and racial and ethnic minority populations in samples (e.g., Curenton, 2010; Brown et al., unpublished manuscript). As a result of their focus, these researchers are regularly challenged and criticized about the validity and necessity of their work (Sue, 1999). Common criticisms highlight that these studies may lack control groups of children from majority or middle-income populations. Further, there is reluctance to include such studies as part of converging evidence about typical developmental trends. Although these arguments suggest a desire to maintain basic experimental control and internal validity, they have made research of underrepresented groups difficult to conduct and fund (Sue, 1999). This suggests the desire to conduct externally valid research exists, but is met with resistance by the scientific community.

Since early comprehension processes are strong predictors of later comprehension and reading skills (van den Broek et al., 2001, 2003, 2005; Brown et al., 2011), it is essential to include children placed at-risk using externally valid assessments (Benson, 1997; Brown et al., unpublished manuscript). Despite this, the current review identified the dearth of such research (see **Table 1**). As at-risk communities typically experience threats to development during critical learning periods, less access to healthcare and resources, and diverse values (Morrow, 1985; Bradley and Corwyn, 2002; Evans, 2004; Curenton, 2010), there may be differences in knowledgebases used to form coherent narrative mental representations (Sharp et al., 1995). It has also been suggested that children from low-income communities have difficulty generating narratives and require additional attention in schools (Fiorentino and Howe, 2004). As a considerable portion of comprehension research has examined children's narrative comprehension through story narration, these findings suggest a new approach may be necessary. For example, future comprehension assessments using familiar or dynamic narrative stimuli (e.g., televised narratives, multimedia books) may provide support to children who struggle with narrative production (Sharp et al., 1995; Wright et al., 2001; Verhallen et al., 2006). We assert then that future research must accommodate and include people from underrepresented groups, particularly children. Using a multi-method approach to assess comprehension will ensure these populations are accurately evaluated. More importantly, though, they will receive the same attention that has identified comprehension difficulties in typically measured populations.

MEDIA TYPE

While knowledge, experiential, and cultural differences may impact children's narrative comprehension processing, the constructionist paradigm argues that these underlying processes are generalizable across narrative media type (Graesser et al., 1994; Kendeou et al., 2005, 2008, 2009). This idea is supported by fMRI investigations by Anderson et al. (2006) that found that comprehending silent filmic montages activated brain regions similar to those activated by comprehending language and narratives. This suggests that comprehension of narrative-structured events recruit similar cortical networks regardless of presentation. These results were confirmed by Kendeou et al. (2008) who found 4- and 6-year-olds' inference generation were interrelated across aural, written, and televised stories. This interdependency continued over time as children turned 6 and 8 years old. Thus, as society becomes increasingly technological, it is necessary that research continue to examine this generalizability of comprehension processing across narrative media during children's development (Anderson and Hanson, 2009; Christakis and Zimmerman, 2009). The Kaiser Family Foundation (Rideout and Hamel, 2006) reported that 81–87% of 2- to 6-year-olds read or are read to everyday, but more than 70% also watch television daily. Further, more than 40% of young children spend 2 hours or more watching television in a typical day and 29–43% have television in their bedroom. Parallel changes in narrative stimuli formats must be considered for the future of comprehension research in order to ensure its external validity.

Still, narrative research often selects wordless picture books as stimuli for young children because they limit distractors and require basic comprehension processes (Pike et al., 2010). This may also be partially due to public resistance toward television and the argument that it negatively impacts cognitive and social development (Vandewater et al., 2007; Schmidt et al., 2008; Kirkorian et al., 2009). A growing body of research, however, refutes this assertion and suggests that regulating the amount of media exposure and content may actually benefit and educate children (Schmidt and Vandewater, 2008; Kirkorian and Anderson, 2009; Anderson and Hanson, 2009; Kirkorian et al., 2009). For example, educational programs such as *Sesame Street* and *Blues Clues* use goal-oriented narratives to discuss topics later covered in schools and to teach problem solving (Kirkorian et al., 2008). The promise of such programming suggests that narrative

media may be beneficial in assessing and improving children's comprehension processing.

It seems apparent then that both developmental appropriateness and potential benefits of media narratives must be considered for the future of comprehension research. For example, dynamic conventions associated with televised narratives for children (e.g., scene changes, transitions, off-screen audio) may be too complex for children younger than 24 months (Anderson and Hanson, 2009, 2010; Kirkorian et al., 2009, 2012; Pempek et al., 2010). Alternatively, it has been suggested that elaborate visual information enhances comprehension processing in young children (Shapiro and Hudson, 1991; Pearce, 2003; Orrantia et al., 2014). By 3 years old, it appears that children can discriminate between symbolic representations of the world and the real world efficiently enough to engage in instructional problem solving (e.g., 3-year-olds can watch a video of a toy hidden in a room, and later locate the hidden toy when brought into a room identical to the depiction; Schmitt and Anderson, 2002). As an extension, it is possible that dynamic visual information accompanied by auditory information available in television has greater benefits to comprehension processes as children mature. Indeed, storybooks presented in a multimedia format were found to improve causal inference generation, narrative retellings, and overall coherence in 5-year-olds placed at-risk compared to storybooks with static pictures (Verhallen et al., 2006). These studies suggest that, while comprehension processes generalize across media formats, certain populations may benefit from different or enhanced narrative presentations.

When contemplating the future of comprehension research, it is important to change opinions regarding narrative media in order to identify and maximize benefits for children (Anderson and Hanson, 2009; Christakis and Zimmerman, 2009). Using non-traditional narrative media presentations, such as television or interactive "e-books," may reduce cognitive load, improve recall of narrative events, and enhance story comprehension for children (Gibbons et al., 1986; Sharp et al., 1995; Linebarger and Piotrowski, 2009; Korat, 2010). As an increasingly technological society, researchers must consider the ecological validity of laboratory stimuli (Pearce, 2003). This is particularly important for children from underrepresented communities who often have more access to televisions than print media (Sharp et al., 1995; Neuman and Celano, 2001; Evans, 2004; Rideout and Hamel, 2006). It is imperative that narrative stimuli be developmentally and ecologically appropriate for all children's comprehension processes.

CONCLUSION

This review argued for intentional changes to increase the external validity of narrative comprehension development research. Pervasive internal validity emphasis within the scientific community has deemphasized external validity and led to unbalanced research practices (Sue, 1999). This endeavor requires future studies employ externally valid rationales in order to fill important gaps in the current literature. An intentional shift toward balancing converging evidence with internally and externally valid studies will ensure accurate assessment of future children's comprehension. As a research area with significant academic implications, future work must include traditionally understudied and underserved populations (Sharp et al., 1995; Sue, 1999; Neuman and Celano, 2001; Evans, 2004; Rideout and Hamel, 2006) who continue to struggle in reading achievement (NCES, 2011; Federal Interagency Forum on Child and Family Statistics, 2013). This will require the intentional inclusion of diverse populations and increase in cultural validity of laboratory studies (Sue, 1999; Quintana et al., 2006; McLoyd, 2013).

The theoretical framework of this review, the constructionist paradigm (Graesser et al., 1994), lends itself to applied future studies that would improve the generalizability of converging comprehension research. Therefore, intentional inclusion of underserved and underrepresented children in future studies will provide a more accurate, holistic view of and how environmental factors contribute to comprehension development. Accompanying this inclusion, researchers must be mindful of differences in knowledgebases when creating age and culturally appropriate narratives for assessment. This, in turn, will offer clearer insight into improving assessments for underserved populations (e.g., using narrative stimuli that are sample-appropriate and ecologically valid). Through the purposeful investigation of these populations, improved comprehension measures will be developed to benefit all children.

We would be misguided to ignore societal changes that impact child development, and must, therefore, adapt methodology to assess narrative comprehension in the current era (Anderson and Hanson, 2009; Christakis and Zimmerman, 2009). Indeed, policies and practices within research laboratories must also reflect this (McLoyd, 2013). The constructionist paradigm of narrative comprehension has the potential to explain comprehension through previously excluded narrative stimuli (Graesser et al., 1994; Kendeou et al., 2005, 2008, 2009). The outcomes of such changes remain an empirical question similar to ideas concerning generalizability across populations (Sue, 1999; Brown et al., unpublished manuscript). Broadening the scope of narrative comprehension research will only have positive implications for academic and societal outcomes. When research balances internal and external validity we will be able to truly assess when, and how, all children comprehend.

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APPENDIX A

DESCRIPTION OF TABLE 1

Table 1 describes 71 sources observing comprehension processes in children. Some studies did not explicitly identify the comprehension processes as described in this paper. In such cases, studies assessing constructs such as "causal relatedness," "inference-making," and "relations between events" were understood to be measuring causal inference generation. Constructs such as "event relatedness," "goal actions," and "intentionality" were understood to be measuring goal structure understanding. "World knowledge," "general knowledge," and "generalization of knowledge" were understood to be measuring knowledge integration. **Table 1** also distinguishes these processes according to sample-income. When not made explicit, maternal and paternal education means at, or above, 16 years were considered proxies for middle-income status. Studies without indicators of socioeconomic status were assumed to have examined middle- to high-income samples and are noted in Appendix B by an asterisk (*).

APPENDIX B

Sources Describing Narrative Comprehension Processes Across Low- and Middle- to High-Income Households.

Studies of Child Samples Representing Lower-Income Households:

Assessing Goal Structure Understanding

1. Benson, 1997
2. Brown et al., unpublished manuscript
3. Eaton et al., 1999
4. Gorman et al., 2011
5. Linebarger and Piotrowski, 2009
6. Morrow, 1985
7. Orrantia et al., 2014
8. Paris and Paris, 2003
9. Pelletier and Astington, 2004
10. Tompkins et al., 2013
11. Verhallen et al., 2006

Assessing Causal Inference Generation

1. Benson, 1997
2. Florit et al., 2011
3. Milch-Reich et al., 1999
4. Pelletier and Astington, 2004
5. Sperry and Sperry, 1996
6. Tompkins et al., 2013
7. Zucker et al., 2010

Studies of Child Samples Representing Middle-Income to High-Income Households*:

Assessing Knowledge Integration

1. Best et al., 2008
2. Bowyer-Crane and Snowling, 2005*
3. Brandão and Oakhill, 2005*
4. Cain et al., 2001*
5. Long et al., 1989*
6. McNamara et al., 1996*
7. Murachver et al., 1996
8. Nicholson and Imlach, 1981*
9. Pearson et al., 1979

Assessing Goal Structure Understanding

1. Aldrich et al., 2011*
2. Bauer et al., 1999
3. Bauer and Shore, 1987*
4. Berman, 1988*
5. Berman, 1995*
6. Berman, 2004*
7. Berman and Slobin, 1994*
8. Brown et al., 1986*
9. Cain et al., 2004*
10. Eaton et al., 1999
11. Henderson and Woodward, 2011*
12. Kirkorian et al., 2012*
13. Lorch et al., 2006*
14. Lorch et al., 2010*
15. Lorch et al., 1999b*
16. Low and Durrkin, 1998
17. Lynch and van den Broek, 2007
18. Lynch et al., 2008
19. McCabe et al., 2008
20. McNamara et al., 1996*
21. Morrow, 1985
22. Murachver et al., 1996
23. Omanson et al., 1978*
24. Pearce, 2003*
25. Pelletier and Astington, 2004
26. Pyykkönen and Järvikivi, 2012*
27. Renz et al., 2003*
28. Sommerville and Woodward, 2005*
29. Tannock et al., 1993*
30. Tompkins et al., 2013
31. Trabasso and Nickels, 1992
32. Trabasso et al., 1992
33. van den Broek et al., 2003*
34. van den Broek et al., 1996*
35. Wenner, 2004
36. Wenner and Bauer, 1999
37. Wigglesworth, 1997

Assessing Causal Inference Generation

1. Bauer, 1992*
2. Bauer et al., 1998
3. Bauer et al., 1999
4. Bauer and Shore, 1987*
5. Brandão and Oakhill, 2005*
6. Brown et al., 2011
7. Cain et al., 2001*
8. Cain et al., 2004*
9. Cohen et al., 1999*
10. Florit et al., 2011

11. Gibbons et al., 1986*
12. Henderson and Woodward, 2011*
13. Kendeou et al., 2008*
14. Kendeou et al., 2009*
15. Kim et al., 2008*
16. Kulkofsky et al., 2008
17. Lorch et al., 1999a*
18. Lorch et al., 2004*
19. Lorch et al., 2010*
20. Lorch et al., 2000*
21. Lorch et al., 1999b*
22. Low and Durrkin, 1998
23. McNamara et al., 1996*
24. Milch-Reich et al., 1999
25. Omanson et al., 1978*
26. Pelletier and Astington, 2004
27. Pike et al., 2010*
28. Schulz and Gopnik, 2004
29. Tompkins et al., 2013
30. van den Broek et al., 2003*
31. van den Broek et al., 1996*
32. Wenner, 2004
33. Wenner and Bauer, 1999
34. Wolman et al., 1997

Studies without indicators of socioeconomic status were assumed to have examined middle- to high-income samples and are noted here by an asterisk (*).

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Learning from picture books: Infants' use of naming information

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The present study investigated whether naming would facilitate infants' transfer of information from picture books to the real world. Eighteen- and 21-month-olds learned a novel label for a novel object depicted in a picture book. Infants then saw a second picture book in which an adult demonstrated how to elicit the object's non-obvious property. Accompanying narration described the pictures using the object's newly learnt label. Infants were subsequently tested with the real-world object depicted in the book, as well as a different-color exemplar. Infants' performance on the test trials was compared with that of infants in a no label condition. When presented with the exact object depicted in the picture book, 21-month-olds were significantly more likely to attempt to elicit the object's non-obvious property than were 18-month-olds. Learning the object's label before learning about the object's hidden property did not improve 18-month-olds' performance. At 21-months, the number of infants in the label condition who attempted to elicit the real-world object's non-obvious property was greater than would be predicted by chance, but the number of infants in the no label condition was not. Neither age group nor label condition predicted test performance for the different-color exemplar. The findings are discussed in relation to infants' learning and transfer from picture books.

Keywords: symbolic understanding, transfer of learning, labels, representation, infants

INTRODUCTION

In Western societies, picture books are amongst the most common symbolic media that infants and young children encounter in their daily lives. Over the second year of life, infants in these cultures spend considerable time in shared picture book reading interactions with their parents (Payne et al., 1994; Gelman et al., 1998; Karrass et al., 2003). For example, in a recent large-scale survey, parents reported spending an average of 25 min per day reading with their 6- to 23-month-old infants (Rideout, 2011).

It is widely assumed that infants, like older children, learn about the world from these picture book interactions. Previous research has established that, by preschool age, children understand the referential nature of pictures and will use them both as symbols and sources of information about the entities they represent (e.g., DeLoache, 1991; DeLoache and Burns, 1994; Harris et al., 1997; Callaghan, 1999, 2000; Callaghan and Rankin, 2002). For example, by 4 years of age, children can learn new biological facts from picture books and transfer this information to real animals (Ganea et al., 2011).

Recent evidence indicates that symbolic understanding of pictures emerges in the second year of life (e.g., Preissler and Carey, 2004; Simcock and DeLoache, 2006; Ganea et al., 2008, 2009; Keates et al., in press) and that under supportive circumstances, infants can transfer simple information from depicted to real-world objects. For example, infants as young as 15-months of age can extend newly learnt labels from objects depicted in picture books to their real-world referents (Preissler and Carey, 2004; Ganea et al., 2008, 2009). Children aged 18-, 24-, and 30-months will also imitate an action sequence depicted in a picture book on novel real-world objects (Simcock and DeLoache, 2006, 2008; Simcock and Dooley, 2007; Simcock et al., 2011). Although infants are generally able to learn new information from picture books, their transfer of information from picture books to the real world is influenced by a number of factors, including the iconicity of the pictures (Simcock and DeLoache, 2006; Ganea et al., 2008, 2009) and the similarity between context or stimuli at encoding and test (Simcock and Dooley, 2007). A recent study by Keates et al. (in press) provided an important extension to the literature by demonstrating that 13-, 15-, and 18-month-old infants can learn about depicted objects' hidden properties and subsequently transfer this knowledge to the real world. This ability, however, was relatively tenuous among individual infants - even at 18-months, approximately half of infants did not attempt to elicit the hidden properties. Taken together, the results of these studies raise the possibility that infants do not learn as much from parent-child picture book interactions as has generally been assumed, and that their ability to transfer this knowledge to the real world may be fairly limited. A question that emerges then is whether it is possible to improve infants' transfer of learning from picture books by providing them with supporting information.

The goal of the present study was to examine whether providing a label for a depicted object facilitates infants' transfer of information about that object's properties from picture books to the real world. Using the hidden property paradigm of Keates et al. (in press), the present study investigated whether teaching 18- and 21-month-old infants labels for objects depicted in

picture books, prior to teaching them about the objects' properties, would help them generalize this information to the objects' real-world referents. Understanding the conditions under which infants demonstrate more robust learning from picture books is important because, like other symbolic media, picture books enable infants to acquire information about the world indirectly. Accordingly, identifying ways to enhance infants' ability to transfer knowledge from pictures books would afford them vastly greater opportunities for learning.

There is evidence that providing a name for depicted objects to infants in their third year enhances their appreciation of depictions' symbolic status (e.g., Callaghan, 2000; Preissler and Bloom, 2007). For example, in a picture-object matching task, 2.5-year-olds succeeded in identifying depicted objects' real-world referents *only* when their labels were known or when the depicted objects were labeled (Callaghan, 2000). Labeling has also been found to facilitate categorization, ostensibly by increasing the salience of object similarities (Waxman, 2008). Infants as young as 12-months of age will use shared object names to determine whether two objects belong to the same category, and continue to do so even when objects share minimal perceptual similarity (e.g., Booth and Waxman, 2002, 2003; Graham et al., 2004; Keates and Graham, 2008). In addition, it has been proposed that verbal cues, such as naming, may serve as a memory retrieval cue (Herbert and Hayne, 2000; Hayne and Herbert, 2004; Barr, 2010). For example, non-sense verbal labels have been shown to facilitate 24-month-olds' deferred imitation from television (Barr and Wyss, 2008). Thus, previous research suggests that a label should provide infants with a cue to both the similarity between depicted and real-world objects, as well as the depictions' symbolic function.

In the present study, infants were assigned to either a *label* condition or a *no label* condition. Using the picture book procedure of Ganea et al. (2008, 2009), infants in the label condition were taught a novel label (e.g., "blicket") for a depicted novel object. Infants in the no label condition received equal exposure to the picture book, but were not provided with a label for the depicted object. Infants in both conditions were then shown a second picture book, in which a sequential series of pictures depicted an adult performing a target action to elicit the object's non-obvious property (e.g., pushing on an object to make it light up). In the label condition, the newly learnt label was used to describe the object as the adult interacted with it. In the no label condition, the narration described the adult interacting with the object without the use of a label. At test, infants were presented with a real, 3D object identical to the one depicted in the picture book. They were subsequently presented with a different color exemplar of the object.

The primary question of interest was whether infants in the label group would be more likely than infants in the no label group to learn and transfer a non-obvious property from a picture book, as demonstrated by their performance of the target action on the real-world object. Further, we aimed to determine whether infants in the label condition would be more likely than infants in the no label condition to generalize their learning to the different color exemplar. The ability to generalize knowledge about an object's non-obvious property to a novel exemplar would indicate more robust learning, given that infants would have to overcome even greater perceptual differences between the depicted object and its real-world referent. An additional question we sought to address was whether there would be age-related differences in the effectiveness of naming information. Accordingly, both 18- and 21-month-olds were tested. Age-related changes in infants' ability to benefit from naming information were anticipated based on documented age-related constraints on infants' memory flexibility (Barr, 2013) and working memory (Garon et al., 2008), as well as previous research demonstrating changes in infants' symbolic use of pictures between 18- and 24-months of age (e.g., Simcock and DeLoache, 2006; Ganea et al., 2009).

MATERIALS AND METHODS

PARTICIPANTS

Participants were 96-, 18-, and 21-month-old infants. Infants in each age group were assigned to one of two conditions: the *label* condition or the *no label* condition. Infant demographic information is presented in **Table 1**. An additional 29 infants were tested, but were excluded from the final sample due to excessive fussiness ($n = 21$), parental interference ($n = 1$), or failure to learn at least one label ($n = 5$) in the label condition. Participants were recruited at local trade shows and

Table 1 | Infant demographic information as a function of age and condition.

	Age		CDI		Books	Gender
	M (SD)	Range	M (SD)	Range	M (SD)	
18-month-olds						
No label condition	18.6 (0.2)	18.1–18.9	142 (131)	9–438	5.5 (4.5)	12 Female12 Male
Label condition	18.5 (0.2)	18.1–18.9	67 (53)	8–199	5.0 (4.0)	10 Female12 Male
21-month-olds						
No label condition	21.6 (0.2)	21.1–22.0	150 (108)	12–393	4.5 (3.7)	11 Female14 Male
Label condition	21.5 (0.3)	21.0–22.0	212 (122)	30–428	5.0 (4.7)	12 Female13 Male

Age = age in months; CDI, number of words produced based on parental report on the MacArthur-Bates CDI; Books, number of books parents report reading with their infant daily.

through community advertisement. All infants were born full-term and came from homes in which English was the primary language spoken. This study was approved by the Conjoint Ethics Research Board at the University of Calgary. Parental consent for participation was obtained in writing prior to the testing session.

MATERIALS

Object sets

Two object sets were used throughout the study: a light object set and a box object set (see **Figure 1**). Each set consisted of four objects: a target object, a non-target object, a generalization target exemplar, and a generalization non-target exemplar. The target box object was a square-shaped box (13 cm in width × 13 cm in length × 13 cm in height) covered with fuzzy, blue polar fleece and topped with two long pieces of the same material, crossed over one another. The box was filled with colorful ribbon, which was attached to a spring glued to the bottom of the box. When the lid of the box was lifted, the ribbon inside the box "popped up." The generalization target exemplar was constructed identically to the target object, but was covered with black fuzzy polar fleece. The non-target object was a rubber ball (3.34 cm in diameter) covered with orange corduroy and shaped with string and sponge. The generalization non-target exemplar was identical to the non-target object, but it was covered with grey corduroy. The target light object was a push light (21 cm in width × 21 cm in length × 2.5 cm in height) covered with yellow felt. The generalization target exemplar was a push light covered with pink felt. The light inside the felt lit up when pressure was applied to the top of the object. The non-target object was a triangular prism (10 cm in width × 12 cm in length × 9 cm in height) covered with purple foam. The generalization non-target exemplar was identical to the non-target object, but it was covered with green foam.

Labeling phase

Stimuli consisted of two picture books (25 cm × 30 cm), one for each object set. Each picture book contained 14 color photographs (19 cm × 13 cm): four photos of a novel target object,

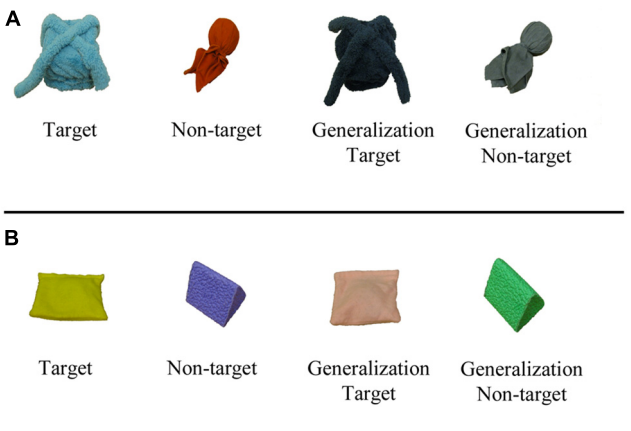

FIGURE 1 | (A) The box object set. **(B)** The light object set.

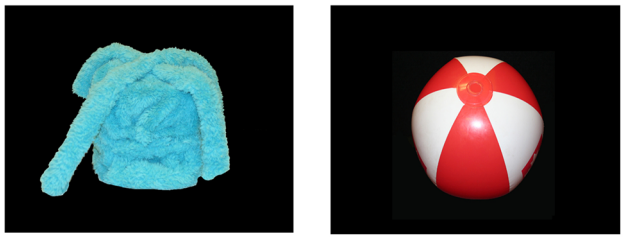

FIGURE 2 | Two pictures used in the word learning phase and the label comprehension phase. These pictures show a ball and the box target object.

four photos of a novel non-target object, and six photos of familiar objects. The same six familiar objects were used for both picture books (shoe, ball, cup, apple, bottle, car), and had labels produced by at least 90% of 18-month-old infants, as indicated by the MacArthur-Bates Lexical Developmental Norms (Dale and Fenson, 1996). Typed narration was provided below each picture. When the book was open, infants saw two pictures side-by-side (see **Figure 2**). Throughout the book, pictures of familiar and novel objects were presented on opposite pages, with the exception of the final two pages, where the novel target and non-target were presented together.

Label comprehension phase

Stimuli consisted of a subset of the photographs used during the labeling phase (bottle, car, ball, cup, light object target, light object non-target, box object target, box object non-target). Each photo was presented on an individual, laminated page (22 cm × 29 cm).

Non-obvious property phase

Stimuli consisted of two picture books with dimensions identical to those of the books used during the labeling phase. Each picture book contained 12 color photographs of an adult seated at a table with a novel object. In six photos, the adult was depicted with the target object and in six photos the adult was depicted with the non-target object. For the target, the adult performed an action that elicited the object's non-obvious property, and for the non-target, the adult explored the object without performing an action on it (see **Figures 3A,B**). Each photo was presented individually, such that when the book was open, the picture was on the right side of the book. Typed narration was provided below each picture.

Test phase

Stimuli consisted of eight objects, four from each of the two object sets described above (i.e., the box set and the light set). The target and non-target objects were used for the extension trials and the generalization target and non-target exemplars were used for the generalization trials. A handheld stopwatch was used to time the trials.

PROCEDURE

The infant was seated across a table from the experimenter, either in a booster chair or on the parent's lap. The parent was instructed not to direct, prompt, or cue the infant during the task. The parent

FIGURE 3 | Sequence of pictures used in the non-obvious property phase. (A) The target object of the box object set. **(B)** The non-target object of the box object set. Adapted from Keates et al. (in press).

was further instructed to place objects back within reach of the infant if the infant handed the objects to them or dropped the objects on the floor. Testing consisted of two blocks of four phases: labeling phase, label comprehension phase, non-obvious property phase, and test phase. Each block corresponded to one object set (i.e., box set or light set). The order of blocks was counterbalanced across participants. For coding purposes, all sessions were recorded using a 6.1 MP Sony Digital HD video camera.

Labeling phase

The experimenter sat next to the child at a table, and read the typed narration while pointing to the depicted objects. For each familiar picture, the experimenter labeled the object once (e.g., "Look, it's a car"). For the novel target object, the experimenter labeled the object three times (e.g., "Look, this is a *blicket*. Wow, it's a *blicket*. See a *blicket*?"). For the non-target object, and the target object in the no label condition, the experimenter drew the infant's attention to the object three times without labeling it (e.g., "Look, look at that. Wow, it's that. See that?"). For each pair of pictures (i.e., a familiar object and novel object), the familiar object was presented first, on the left side of the book, and the novel object was presented second, on the right side of the book. The order in which the novel target and non-target objects were presented in the picture book was counterbalanced across infants.

Label comprehension phase

During this phase, the experimenter sat across the table from the infant. For infants in the label condition, the experimenter presented two pictures of familiar objects and asked the infant to indicate one of them ("Show me the car [ball, shoe, cup]"). The object requested, as well as the side on which the target picture presented, was counterbalanced across participants. If the infant did not respond, the experimenter used alternate phrases (e.g., "Where's the car?" or "Point to the car"), until a response was elicited. If the infant did not respond to the experimenter, the

experimenter instructed the parent to repeat the phrases, until a response was elicited. On subsequent trials, the experimenter asked the child to indicate the objects using whichever phrase had elicited a response. Then, to assess whether infants had learnt the novel label for the depicted target object, the experimenter presented two photographs: one of the novel target and one of the novel non-target. She then asked the infant to indicate the target ("Show me the blicket"). Infants were given positive reinforcement (e.g., "That's right! Good job!") when they chose the target picture and were given corrective feedback (e.g., "Remember, this one is the blicket") when they chose the non-target. The criterion was two correct successive responses on two trials, with a maximum of four possible trials, following that used in previous research (e.g., Ganea et al., 2009).

Infants in the no label condition were also shown the pair of familiar objects and the pair of novel objects (i.e., target and non-target). Rather than being asked to indicate a specific object, infants were asked to show either one of the objects to the experimenter ("Show me one"). The experimenter prompted the infant (as described above), until the infant chose one of the objects. Regardless of the infant's choice, the experimenter provided a neutral response ("Thank you").

Non-obvious property phase

During this phase, the experimenter read the non-obvious property book to the infant in the manner described above. The infant saw a sequence of six photographs of the adult interacting with the first novel object (e.g., the target), followed by a sequence of six photographs of the adult interacting with the second novel object (e.g., the non-target). The narration for the target object described the adult eliciting the object's non-obvious property by performing the target action. In the label condition, the pictures were described using the object's newly learnt label (i.e., the label that was taught during the labeling phase). In the no label condition, the pictures were described without the use of a label to refer to the target object. In both conditions, the narration for the non-target object described the adult exploring the object without performing an action. The narration was approximately equivalent in length for the target and non-target picture sequences in order to equate the attention paid to both depicted objects. The order of the six pictures within each sequence was fixed, but the order of presentation of the sequences (i.e., target vs. non-target sequence presented first) was counterbalanced across infants.

Test phase

During this phase, the experimenter sat across the table from the infant. For the extension trial, she simultaneously placed the exact target and non-target objects that were depicted in the book on the table, out of reach of the infant. In the label condition, she introduced the objects to infants using the newly learnt label (e.g., "Look. There's a blicket here. Now you get to play!"). In the no label condition, she introduced the objects by substituting the word "toy" for the object label (e.g., "Look. There's a toy here. Now you get to play!"). She then moved the objects within the infant's reach and gave the infant the opportunity to explore the objects for 20 s.

After 20 s had elapsed, the experimenter retrieved the two objects and intitiated the generalization test trial. The experimenter simultaneously placed the generalization target and non-target exemplars on the table, out of reach of the infant. She introduced the objects using the same newly learnt label (e.g., "Look. There's a blicket here. Your turn again!") for infants in the label condition, or substitued the word "toy" for infants in the no label condition. She then placed the objects within the infant's reach. The infant were again given 20 s to explore the two objects. If, over the course of the 20 s exploration period, the infant could no longer reach the object, the experimenter or parent re-placed the object in front of the infant within his or her reach.

The extension test trial was always presented before the generalization test trial. Consistent with previous research examing children's transfer from picture books (e.g., Ganea et al., 2008), it was reasoned that presenting the test trials in this order would help to clarify interpretation of infants' performance. That is, our primary objective was to investigate infants' transfer from picture books, and the clearest test of this tranfer was the extension trial. If the generalization test were presented first, and infants failed to demonstrate evidence of transferring the depicted property, it would be unclear whether they were (a) unable to generalize to a novel exemplar, or (b) unable to tranfer from the picture book to a real object more generally. As a result, it was determined that having the extension trial precede the generalization would simplify the interpretation of infants' performance, despite limiting conclusions that could be drawn about infants' generalization (i.e., the extent to which infants can generalize non-obvious properties to novel exemplars, in the absence of experiencing a more similar exemplar first).

Once the first block of trials was completed, the second block of trials was administered for the other object set. Following the testing session, the parent was asked to complete the MacArthur-Bates Communicative Development Inventory: Words and Sentences (CDI; Fenson et al., 2007), a measure of productive vocabulary. The parent was also asked to indicate the number of picture books the infant and parent read together per day.

CODING AND RELIABILITY

Infants' attempts to elicit the target objects' non-obvious properties were coded offline by trained coders, unaware of the experimental hypotheses and participants' condition. The target action for the box object set was defined as forcefully pulling upward on the material on top of the object. Picking at or touching the material on the top of the object without lifting or pulling the material, lifting the long pieces of material on the top of the object without using force (e.g., lightly holding them a vertical position), or shaking or squeezing the object, were not coded as target actions. The target action for the light object set were defined as hitting, pushing on, or tapping the object with the hand or fingers using a swift "tap-like" motion. Actions performed on the excess felt around the push light, rather than on the top or side of the felt-covered push light itself, were not coded as target actions. Lightly resting a hand on top of the object, without pushing or applying pressure, or touching the object in order to feel or poke it, were also not coded as target actions. For both object sets, actions

performed in order to pick up, throw, move the object closer to oneself, or pass the object to either the parent or the experimenter, were not coded as target actions.

Coders also recorded the amount of time infants spent examining the target or non-target objects. Examination time was used as a measure of infants' interest in the objects, and was defined as the number of seconds spent looking at, or looking at and touching, the objects.

An additional coder, unaware of the experimental hypotheses and condition, coded 20% of the videos. Inter-rater reliability for target actions on target objects was high ($\kappa = 0.968$). Inter-rater reliability for examination time coding was also high (intraclass correlation coefficient = 0.980).

PREDICTIONS

First, we predicted that infants in the label condition would be more likely than infants in the no label condition to perform the target actions on the real-world objects for both the extension and generalization trials. Furthermore, we expected that the facilitative effects of the label might be more pronounced for the generalization trial, because of the challenge inherent in transferring to a more perceptually dissimilar exemplar. Second, we predicted that there would be age-related changes in infants' ability to benefit from naming information, with greater differences between the label and no label conditions at 21-months than at 18-months. Finally, it was anticipated that infants in the label condition, across both age groups and test trials, would spend more time examining the target object relative to the non-target object, but that infants in the no label condition would examine the target and non-target objects equally.

RESULTS

PRELIMINARY ANALYSES

First, we assessed comprehension of the object labels for infants in the label condition to ensure that infants were in fact mapping the novel label to the depicted target objects so that any observed differences in the performance of the label and no label condition could be attributed to differences in access to naming information. Infants who had not learnt at least one of the object labels were excluded from subsequent analyses ($n = 5$). Overall, 24 of the 47 infants assigned to the label condition demonstrated evidence of learning the novel labels for both targets (i.e., depicted light and box target objects) and 23 of the infants learnt the label for one of the two targets.

Next, within each age group, we examined infants' productive vocabulary and exposure to picture books in order to determine whether these differed between conditions. All analyses were performed using IBM SPSS Statistics software (version 20; IBM Corp., Chicago, IL, USA). The number of books parents reported reading to their infant daily did not vary by age or condition p's > 0.707. The 21-month-old infants had larger productive vocabularies than the 18-month-old infants, $t(94) = 3.24$, $p = 0.002$. The 18-month-olds in the no label group had higher productive vocabulary scores than the 18-month-olds in the label group $t(30.97) = 2.56$, $p = 0.016$. There was no difference in the number of words produced by infants in the label and no label condition at 21-months ($p = 0.064$).

PRIMARY ANALYSES

Infants' learning and transfer of non-obvious properties was analyzed in two ways. First, infants' performance of the depicted target action on the real target object was analyzed to determine whether they had successfully transferred their learning from the depicted target to its real-world referent. Second, the time that infants spend examining the target objects relative to the non-target objects was analyzed as a measure of infants' interest in the target objects during the test trials.

Target actions

Sequential logistic regression analyses were conducted to assess the prediction of test outcome (i.e., whether or not infants performed target actions to elicit objects' non-obvious properties). Only one 18-month-old performed two target actions on the extension trial (across the two testing blocks), and only four 18-month-olds (two per label condition) performed two target actions on the generalization trial (across the two testing blocks). As a result, the number of cases per cell was not sufficient to support a multinomial logistic regression approach. Test outcome was accordingly classified dichotomously. That is, infants were given credit for performing a target action on either the light or the box object target object for the extension trial, and were given credit for performing a target action on either the light or the box generalization target exemplar for the generalization trial. If infants performed target actions on both sets, no additional credit was given. **Table 2** displays the test outcome by condition and age group contingency table for the extension trial. **Table 3** displays the test outcome by condition and age group contingency table for the generalization trial. There was no significant difference between infants' performance of target actions on the light target and infants' performance of target actions on the box object (McNemar test, $p = 0.132$).

Preliminary analyses indicated that the following variables did not meaningfully contribute to the prediction of test outcome: gender, the order in which object sets were presented (i.e., light object set first vs. box object set first), the number of picture books parents reported reading with their infant daily, and the age by condition interaction term. Accordingly, these variables were excluded from subsequent analyses.

Table 2 | Extension trial: Learning as a function of condition and age group.

		Attempt to elicit property		
Age group	**Condition**	**No**	**Yes**	**Total**
18-month-olds				
	No label	14	10	24
	Label	11	11	22
	Total	25	21	
21-month-olds				
	No label	10	15	25
	Label	5	20	25
	Total	15	35	

Table 3 | Generalization trial: Learning as a function of condition and age group.

		Attempt to elicit property		
Age group	**Condition**	**No**	**Yes**	**Total**
18-month-olds				
	No label	12	12	24
	Label	10	12	22
	Total	24	24	
21-month-olds				
	No label	11	14	25
	Label	5	20	25
	Total	16	34	

Extension trial. To explore the contribution of naming to infants' performance on the extension test trial, a sequential dichotomous logistic regression was conducted, with attempt to elicit a target object's non-obvious property for at least one target object set (performance of a target action vs. no performance of a target action) as the dependent variable (**Table 4**). Age group (18-month-olds vs. 21-month-olds) was entered on step 1. Condition (label condition vs. no label condition), was entered on step 2. Productive vocabulary (as indicated by parental report on the MCDI) was entered on step 3. Inclusion of this variable helped address the between-group differences in vocabulary noted above (i.e., the difference between the productive vocabularies of 18-month-olds in the label vs. no label condition), by distinguishing and accounting for the variance explained by condition, and the variance explained by vocabulary.

For step 1, the Likelihood ratio test for the overall model was significant, χ^2 (1, $N = 96$) = 5.90, $p = 0.015$, indicating that compared to a constant-only model, infants' age contributed significantly to the prediction of infants' performance of target actions. The addition of condition to the model in step 2 did not significantly improve the model fit, $p = 0.139$. The Likelihood Ratio test for the overall model remained significant, χ^2 (2, $N = 96$) = 8.09, $p = 0.018$. When productive vocabulary was added to the model in step 3, the improvement in the model fit was again not statistically significant $p = 0.660$, and the Likelihood ratio test for the overall model remained significant χ^2 (3, $N = 96$) = 8.29, $p = 0.040$. The effect size of the model with all three predictors compared to the constant-only model was small, Nagelkerke = 0.111, indicating that these variables accounted for only 11.1% of the between-group variance.

Table 4 | Logistic regression analysis predicting test performance from age group, condition, and productive vocabulary (extension trial).

Predictor	**χ^2 to remove**	**df**	**Model χ^2**
Step 1			5.90*
Age group	5.90*	1	
Step 2			8.09*
Condition	2.19	1	
Step 3			8.29*
Productive vocabulary	0.19	1	

*$p < 0.05$.

Table 5 | Predictors of test performance on the extension trial.

Variable	**OR**	**95% CI**	***p***
Age group	2.65	[1.09, 6.42]	0.03
Condition	1.91	[0.84, 4.49]	0.14
Productive vocabulary	1.00	[1.00, 1.00]	0.66
(Constant)	0.56		0.18

OR, odds ratio; CI, confidence interval.

Table 5 shows regression coefficients, Wald statistics, odds ratios, and 95% confidence intervals for the odds ratios for each individual predictor. The only predictor that contributed to the prediction of whether an infant would attempt to elicit a non-obvious property by performing a target action was age, $B = 0.97$, $SE = 0.45$, $Wald(1) = 4.64$, $p = 0.031$. For infants in the 21-month-old group, the odds in favor of performing a target action on a target object were 2.65 times larger than for infants in the 18-month-old group; 70% (35/50) of infants in the 21-month-old group performed a target action compared to 46% (21/46) of infants in the 18-month-old group.

Approximately half of infants in the no label condition performed target actions (51%, 25/49). Similarly, approximately half of infants in the Keates et al. (in press) study performed target actions (51%, 31/61). Across different age groups (i.e., 13-, 15-, 18-, and 21-months), it appears that the chance success rate (in the absence of supporting information, such as shared labels) is roughly 50%. In the present study, the number of 18-month-olds who performed target actions did not differ reliably from chance (i.e., 50%), χ^2 (1, $N = 46$) = 0.35, $p = 0.555$. Conversely, the number of 21-month-olds who performed target actions was reliably higher than would be predicted by chance, χ^2 (1, $N = 50$) = 8.00, $p = 0.005$. Within the 21-month-old group, more infants in the label condition performed target actions than would be predicted by chance, χ^2 (1, $N = 25$) = 9.00, $p = 0.003$, however, the performance of infants in the no label condition did not differ reliably from chance, χ^2 (1, $N = 25$) = 1.00, $p = 0.317$.

Generalization trial. To explore the contribution of naming to infants' performance on the generalization test trial, a second sequential dichotomous logistic regression was performed (see **Table 6**). The dependent variable and predictors, as well as the steps of the analysis, were identical to those described for the extension test trial.

For step 1, Likelihood ratio test for the overall model was not significant, $p = 0.113$, indicating that age group did not contribute to the prediction of performance of target actions. The addition of condition in step 2 did not significantly improve the fit of the model, $p = 0.135$ and the Likelihood Ratio test remained non-significant, $p = 0.093$. The addition of productive vocabulary to

Table 6 | Logistic regression analysis predicting test performance from productive vocabulary, age group, and condition (generalization trial).

Predictor	χ^2 *to remove*	df	Model χ^2
Step 1			2.52
Age group	2.52	1	
Step 2			4.75
Condition	2.23	1	
Step 3			5.97
Productive vocabulary	1.22	1	

the model in step 3 also did not significantly improve the fit of the model, $p = 0.270$. A test of the model with all three predictors against a constant-only model remained non-significant, $p = 0.113$, indicating that the variables, as a set, did not reliably distinguish between infants who had and had not performed target actions.

Examination of the Wald statistic for each of the individual predictors (i.e., age group condition, productive vocabulary) confirmed that none of these variables significantly contributed to the prediction of infants' performance, *p*s > 0.127. Thus, unlike the extension test trial, in which age group was a significant predictor of infants' performance, for the generalization test trial none of the predictors reliably distinguished between infants who learnt and did not learn from the picture book. As in the extension trial, the number of 18-month-olds who performed target actions on the generalization trial did not differ reliably from chance (i.e., 50%), χ^2 (1, $N = 46$) $= 0.087$, $p = 0.768$, whereas the number of 21-month-olds who performed target actions was reliably higher than would be predicted by chance, χ^2 (1, $N = 50$) $= 6.48$, $p = 0.011$. Further examination of the 21-month-old group's performance again revealed that more infants in the label condition performed target actions than would be predicted by chance, χ^2 (1, $N = 25$) $= 9.00$, $p = 0.003$, but that the number of infants in the no label condition performing target actions did not differ reliably from chance, χ^2 (1, $N = 25$) $= 0.36$, $p = 0.549$.

Examination time

In an additional set of analyses, the time that infants spent examining the target objects over the course of the test trials was analyzed. Examination time for target objects was proportionalized by dividing the number of seconds infants spent interacting with the target object by their total examination time for both the target object and non-target object. The proportion of examination time for each object set (i.e., the light object set and box object set) was averaged to yield one mean target object examination time score for each trial type (i.e., extension and generalization). Mean proportion examination times for the target objects, separated by trial, condition, and age group are presented in **Table 7**.

To examine whether infants' examination times for the target objects varied as a function of condition, age group, and test trial, a 2 (*Condition*: Label vs. No Label) × 2 (*Age Group*: 18-month-olds vs. 21-month-olds) × 2 (*Test Trial*: Extension vs. Generalization) mixed factor ANOVA was conducted with test trial as a repeated measure. This analysis revealed a significant main effect of age group, $F(1,92) = 6.78$, $\eta_p^2 = 0.07$, $p = 0.011$, with 21-month-old infants spending significantly more time examining the target objects on the test trials than 18-month-old infants. There was also a significant main effect of test trial, $F(1,92) = 10.78$, $\eta_p^2 = 0.11$, $p = 0.001$, with infants spending significantly more time examining the target objects on the generalization test trials than on the extension test trials. There was no effect of condition and there were no two-way or three-way interactions involving age group, test trial, or condition, *p*'s > 0.074. These results suggest that infants in the label and the no label conditions were equally interested in the target objects. As a group, the 21-month-olds were significantly more interested in the target objects than the 18-month-olds, and across age groups, infants were more interested in the generalization target exemplars than the exact target objects depicted in the picture books.

Table 7 | Mean proportion examination times for the target object by condition and age group (extension and generalization trials).

		Test trial	
		Extension	Generalization
Age group	**Condition**	***M* (SD)**	***M* (SD)**
18 Months			
	No label	0.45 (0.24)	0.56 (0.22)
	Label	0.45 (0.16)	0.55 (0.18)
	Mean[a]	0.45 (0.20)	0.56 (0.20)
21 Months			
	No label	0.56 (0.20)	0.60 (0.17)
	Label	0.57 (0.16)	0.62 (0.19)
	Mean[a]	0.57 (0.18)	0.61 (0.18)

[a] *Averaged across condition.*

DISCUSSION

The present study investigated whether naming would facilitate infants' transfer of complex information from picture books to the real world, as well as potential age-related differences in the effectiveness of this verbal cue. When infants were presented with the exact object depicted in the picture book (the extension trial), age was an important predictor of performance of target actions. Specifically, for infants in the 21-month age group, the odds of attempting to elicit a target object's non-obvious property were almost 2.65 times greater than for infants in the 18-month age group. For the extension trial, the presence of label information did not influence 18-month-olds' performance; the number of 18-month-olds who performed target actions in both the label and no label condition did not differ reliably from chance. Similarly, the number of 21-month-olds who performed target actions in the no label condition did not differ from chance. Thus, the only condition in which the number

of infants performing target actions was greater than would be predicted by chance was the 21-month-old label condition. When presented with a different color exemplar of the object depicted in the picture book (generalization trial), neither age group nor label condition distinguished between the infants who performed target actions and those who did not perform target actions.

EXTENSION TRIAL

On the extension trial, older infants were more likely than younger infants to transfer objects' non-obvious properties from picture books to real-world objects, a finding consistent with previous research demonstrating increases in infants' symbolic understanding of pictures over the second year of life (e.g., Simcock and DeLoache, 2006; Simcock and Dooley, 2007; Ganea et al., 2009). These age-related differences have been attributed to both children's emerging symbolic capacity, as well as greater flexibility in mental representations (e.g., Simcock and DeLoache, 2006; Barr, 2013). Interestingly, the age-related changes in infants' performance in the current research differ from the findings of Keates et al. (in press), where infants 13-, 15-, and 18-months of age did not differ significantly in their attempts to elicit the depicted non-obvious property with the real target object. One possibility is that between 13- and 18-months of age, infants' symbolic understanding of picture books is fairly comparable, with this understanding then developing rapidly between 18- and 21-months of age. Another possibility is that the age effects of the present study can be partially attributed to the facilitation observed in the 21-month-old label condition. That is, as a result of the greater number of infants in the 21-month-old label condition performing target actions, the overall number of 21-month-olds performing target actions was significantly greater than the number of 18-month-olds.

The finding that labels facilitated 21-month-olds' transfer from picture books on the extension trial is consistent with other research that has shown that verbal cues improve imitation from not only picture books, but also television, another 2D symbolic medium (e.g., Barr and Wyss, 2008; Barr, 2010; Seehagen and Herbert, 2010; Simcock et al., 2011). In contrast to the facilitation observed at 21-months, the presence or absence of naming information did not appear to influence infants' performance on the extension trial at 18-months. This was unexpected, given that previous research has documented the facilitative effects of naming in other types of tasks, as well as with even younger infants (e.g., Booth and Waxman, 2002, 2003; Graham et al., 2004; Keates and Graham, 2008; Waxman, 2008; Herbert, 2011). The lack of facilitation reported here likely resulted from two factors. One is the cognitive demands placed on infants in the label group: they had to encode and form a representation of the target object and its label, and then hold this information in mind while learning how to elicit the object's non-obvious property. In order to succeed on the test trials, infants then had to simultaneously activate the representation of the object, its label, its non-obvious property, and how to elicit this property. Finally, infants had to select the correct target object and perform the appropriate target action. It is possible that the task demands taxed 18-month-olds' cognitive resources, interfering with their ability to use the naming information that was provided[1]. The second factor is the well-documented challenges experienced by infants faced with the task of transferring complex information from 2D to 3D contexts (Barr, 2010, 2013). Studies examining infants' imitation of action sequences from pictures have consistently found that 18-month-olds who are presented with a depicted, three-step action sequence do not re-enact the entire sequence (Simcock and DeLoache, 2006; Simcock and Dooley, 2007), and further, have difficulty producing the target actions in the correct order (Simcock et al., 2011).

What, beyond the general effect of age, might account for the observed changes in the effectiveness of the naming information between 18- and 21-months? First, 21-month-olds possess more advanced representational systems than 18-month-olds, including language and memory systems, as well as more developed perceptual and motor systems (Barr, 2010). It should be noted however, that infants' productive vocabulary did not uniquely predict performance, suggesting that infants' language proficiency was only one of a number of factors contributing to their performance. Second, 21-month-olds have had more exposure and interaction to symbols in their daily lives, and thus they may have had more opportunities to clarify the symbolic relations between symbols and their referents. Accordingly, they may have a more robust understanding of the symbolic nature of pictures. Finally, 21-month-olds' overall cognitive processing is likely faster, and more flexible than that of younger infants, allowing them to integrate perceptual and linguistic input more quickly (Garon et al., 2008; Barr, 2010).

Similar age-related changes in the ability to benefit from naming information have been reported in studies examining the transfer from touchscreens or television sources to real-world objects. Specifically, a recent study by Zack et al. (2013), examining 15-month-old infants' imitation from touch screens, failed to find facilitation from shared labels. As in the present study, their task was relatively complex, required infants to transfer information from a 2D symbolic medium to a 3D real-world object, and found that the addition of object labels had no effect on infants' transfer. At 24-months, however, non-sense verbal labels provided by either parents or voice-overs were shown to enhance infants' imitation from television (Barr and Wyss, 2008). The parallels in age-related differences across different kinds of 2D to 3D transfer support the notion that developments in general cognitive abilities such as working memory and memory flexibility, as well as developments in representational and symbolic systems, influence the effectiveness of verbal cues such as naming information.

GENERALIZATION TRIAL

Given that the generalization exemplars were less perceptually similar to the depicted objects than the extension exemplars, it was

[1]A condition in which 18-month-olds were presented with the label and object property information simultaneously similarly failed to find a facilitative effect of naming (Keates, 2010). An additional condition, in which 18-month-olds were reminded of the object's label prior to testing, also found no facilitation of transfer (Khu et al., 2012). Accordingly, the manner in which naming information is presented does not appear to be responsible for the lack of facilitation observed at 18-months in the present study.

expected that this test trial would pose a greater challenge, resulting in a greater potential to observe the facilitative effects of naming information. However, neither age group, nor label condition, nor productive vocabulary, meaningfully contributed to the prediction of infants' performance. Contrary to the above-mentioned hypothesis, it appears as though infants were actually *more* interested in the target for this trial relative to the extension trial. As a result of the increased interest, it is possible that the relatively small effect of age became even less pronounced.

The fact that infants' performance was similar across both the extension and generalization trial suggests that, contrary to our predictions, the generalization trial did not pose a greater challenge. It is possible that always having the generalization follow the extension removed any effects by allowing infants to extend their knowledge from the picture book to the extension target object, and from the extension target object to the generalization target object. Furthermore, it is possible that some of the 18-month-olds used their experience with the extension trial to succeed on the generalization trial, obscuring the age effects found on the extension trial. Future research could investigate whether presenting the generalization trial without the extension trial would increase the difficulty of the trial, thereby revealing similar age effects to those observed in the extension trial in the present study, and possibly increasing the likelihood of finding an effect of label condition at 21-months.

FUTURE DIRECTIONS

The results of the extension trial suggest that at 21-months, individual infants' transfer can be facilitated through the provision of supporting information. Future research could examine whether the same type of supporting information, presented differently, could enhance younger infants' transfer. For example, it is possible that in the present study, the novelty of the label, the object, and the label-object pairing may have negatively impacted 18-month-olds' ability to use the label to guide their transfer of information. A training study could examine whether increasing the familiarity of the target object and label, and strengthening the association between them by providing multiple exposures to the object-label pairing over the course of a week, would result in facilitated transfer of the object's non-obvious property at test. It is also possible that labels simply do not enhance transfer from 2D representations to 3D objects prior to 21-months of age. If this were the case, it would be important to investigate whether other kinds of information might facilitate slightly younger infants' learning and transfer. For example, additional research could examine the effects of highlighting the symbolic relationship between pictures and objects (e.g., Callaghan and Rankin, 2002) or the effects of presenting infants with multiple different-colored exemplars of the target object while teaching them about the objects' non-obvious property (e.g., Gentner and Namy, 1999, 2004). This additional research could help to clarify for parents and educators the ideal manner in which to present pictorial information to younger infants.

CONCLUSION

In summary, the present study provides insight into the development of the ability to transfer information from picture books to the real world. The results of the present study extend previous research by demonstrating that shared labels can facilitate the transfer of complex information in infants just before their second birthday. Importantly, this facilitation was not observed in a group of infants only three months younger. Developmental changes in the ability to apply naming information to the task of transferring complex information suggests that parents of infants 21-months and older might be able to scaffold infants' transfer from picture books by providing shared labels for depicted and real-world objects, but that the same educational strategy may not result in comparable facilitative effects for younger infants.

AUTHOR CONTRIBUTIONS

Melanie Khu conducted this research in partial fulfillment of the requirements for the M.Sc. degree, under the supervision of Susan A. Graham. Data from this experiment were included in Melanie Khu's M.Sc. thesis, submitted to the University of Calgary. Patricia A. Ganea was involved in the conception of the project, as well as manuscript preparation.

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Once upon a time, there was a fabulous funambulist. . . : what children learn about the "high-level" vocabulary they encounter while listening to stories

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Previous research has shown that listening to stories supports vocabulary growth in preschool and school-aged children and that lexical entries for even very difficult or rare words can be established if these are defined when they are first introduced. However, little is known about the nature of the lexical representations children form for the words they encounter while listening to stories, or whether these are sufficiently robust to support the child's own use of such "high-level" vocabulary. This study explored these questions by administering multiple assessments of children's knowledge about a set of newly-acquired vocabulary. Four- and six-year-old children were introduced to nine difficult new words (including nouns, verbs and adjectives) through three exposures to a story read by their class teacher. The story included a definition of each new word at its first encounter. Learning of the target vocabulary was assessed by means of two tests of semantic understanding—a forced choice picture-selection task and a definition production task—and a grammaticality judgment task, which asked children to choose between a syntactically-appropriate and syntactically-inappropriate usage of the word. Children in both age groups selected the correct pictorial representation and provided an appropriate definition for the target words in all three word classes significantly more often than they did for a matched set of non-exposed control words. However, only the older group was able to identify the syntactically-appropriate sentence frames in the grammaticality judgment task. Further analyses elucidate some of the components of the lexical representations children lay down when they hear difficult new vocabulary in stories and how different tests of word knowledge might overlap in their assessment of these components.

Keywords: vocabulary, comprehension, listening to stories, definitions, grammaticality judgments, teacher-led intervention, word learning, forced-choice

INTRODUCTION

Having a large and varied vocabulary at one's disposal confers a significant advantage in adulthood, and the same is true for preschool- and young school-aged children. The size of a young child's vocabulary predicts later language competence, reading comprehension, writing skills and general academic achievement (Cunningham and Stanovich, 1997; Storch and Whitehurst, 2002; Dickinson et al., 2003). As described by Chall and Jacobs (2003), the successful development of general knowledge, literacy, and other academic skills depends fundamentally on the child having a sufficient grasp of the language in which they are attempting to learn. Moreover, the benefits of possessing a large vocabulary continue to accrue if the child progresses beyond the level required to meet age-appropriate targets; it is the children with the most sophisticated language skills who show the greatest academic achievements across the curriculum. It has therefore been argued that research should focus on identifying how growth in children's knowledge of "high-level" (or "Tier 2") vocabulary (i.e., words beyond the expected level for the child's chronological age) is best supported (Beck et al., 2002).

In some cases, children acquire rich and diverse vocabulary knowledge through the conversational exchanges that surround everyday activities at home. Beals (1997) analyzed the content of meal-time conversations between parents and their 3- to 5-year-old children and found that the frequency with which parents used rare words and the extent to which they provided "semantic support" for these words (e.g., by defining the word's meaning) predicted the child's performance on standardized tests of vocabulary knowledge at 5 and 7 years of age. Weizman and Snow (2001) similarly found that parents' use of sophisticated vocabulary in conversations with their 5-year-old children—again measured in terms of the number of high-level words used by parents and the level of support they provided children in interpreting these words—explained 40% of the variance in children's vocabulary scores at second grade, after parental education, child language and child non-verbal IQ scores had been controlled for. These studies demonstrate the important role parents play in helping their child to build a large vocabulary. However, many parents will be unable to provide the sophisticated linguistic environment necessary to support the development of high-level

vocabulary; the children in these families are therefore dependent on alternative sources of lexical variety.

Listening to stories has long been acknowledged as an activity that supports vocabulary acquisition in young children (Ninio, 1983; Elley, 1989). Numerous studies have demonstrated gains in word knowledge to result from storytelling to preschoolers (Senechal and Cornell, 1993; Sénéchal et al., 1995; Karweit and Wasik, 1996; Reese and Cox, 1999; Wasik and Bond, 2001; Justice et al., 2005; Walsh and Blewitt, 2006; Wasik et al., 2006) and school-age populations (Dickinson, 1984; Nagy et al., 1987; Elley, 1989; Robbins and Ehri, 1994; Penno et al., 2002; Wilkinson and Houston-Price, 2013). Entry to formal education provides children with further opportunities to engage in activities that support the acquisition of vocabulary knowledge, including explicit instruction and classroom discussion about specific vocabulary items (Beck et al., 1982; Stahl and Fairbanks, 1986; Beck et al., 2002) and, with the onset of literacy, the chance to encounter new words in written texts (Jenkins et al., 1984; McKeown et al., 1985; Nagy et al., 1987). However, children continue to learn new words by listening to spoken language, and to stories in particular, throughout the school years (Dickinson, 1984; Nagy et al., 1987; Elley, 1989; Robbins and Ehri, 1994; Penno et al., 2002; Wilkinson and Houston-Price, 2013); listening to stories is "almost universally praised" (Elley, 1989, p. 176) as a means of promoting vocabulary growth. There are, of course, individual differences in children's ability to profit from listening to stories; many studies have demonstrated the "Matthew effects" (Stanovich, 1986) that are ubiquitous in children's development (Robbins and Ehri, 1994; Sénéchal et al., 1995; Reese and Cox, 1999). However, recent work has shown that children of all ages and abilities are able to learn difficult new words from age-appropriate stories (Wilkinson and Houston-Price, 2013), suggesting that classroom story sessions are a truly "democratic" learning activity.

A key determinant of the success of children's learning of new vocabulary while listening to stories is the manner in which new words are presented. While some degree of learning can result from a single implicit exposure to a new word in context (Dickinson, 1984; Stahl et al., 1991), many studies have shown that learning is facilitated by repeated exposure, whether through repetition of the vocabulary within a story or through repeated readings of the same story (Elley, 1989; Robbins and Ehri, 1994; Karweit and Wasik, 1996; Sénéchal, 1997; Beck and McKeown, 2007). Learning is also supported when the reader provides opportunities for the child to engage interactively with the new vocabulary that they meet. Posing questions that include the new word or that require the child to produce the new word as an answer and engaging in role-play involving the new word all serve to facilitate learning (Sénéchal et al., 1995; Sénéchal, 1997; Ewers and Brownson, 1999; Ard and Beverly, 2004; Walsh and Blewitt, 2006; Blewitt et al., 2009). And just as children benefit from explicit clarification of the meanings of the new vocabulary items they encounter in conversation (Beals, 1997; Weizman and Snow, 2001), they also show greater learning of the vocabulary they meet when listening to stories if the reader provides an age-appropriate definition or synonym for the word, or points to an enlightening illustration to explain its meaning, while reading the text (Elley, 1989; Sénéchal et al., 1995; Brett et al., 1996; Sénéchal, 1997; Reese and Cox, 1999; Penno et al., 2002; Justice et al., 2005; Biemiller and Boote, 2006; Beck and McKeown, 2007; Wilkinson and Houston-Price, 2013).

Recent research from our group has shown that listening to stories including explicit definitions supports children in the acquisition of very difficult vocabulary. Wilkinson and Houston-Price (2013) asked teachers to read stories containing a set of eight high-level words to their Year 2 and 4 classes (7- and 9-year-olds) once a week for 3 weeks. In some conditions, the first mention of each word was accompanied by a child-friendly definition of its meaning. Children were tested on their understanding of the target vocabulary and a matched set of control words three times: at baseline, immediately after the 3-week exposure phase, and again 2 weeks later, to establish the extent to which children retained their learning. Substantial gains in understanding of the target words were made during the listening phase, and these were maintained at least 2 weeks after the story was last heard. Interestingly, analyses of children's longer-term learning showed that the two age groups made equivalent gains in vocabulary knowledge although, as in previous demonstrations of the Matthew Effect (Stanovich, 1986), the greatest gains were shown by children with more advanced vocabulary knowledge, according to their scores on the British Picture Vocabulary Scale (BPVS-II; Dunn et al., 1997). The provision of definitions during the story reading sessions boosted children's understanding of the new words regardless of their age or prior vocabulary knowledge, confirming the importance of providing "semantic support" for high-level vocabulary when it is first introduced.

In Wilkinson and Houston-Price's (2013) study, learning was assessed in terms of children's ability to select the correct pictorial representation of the new words from an array of four pictures; we borrowed both the target vocabulary and the forced-choice test cards for these words from the BPVS-II for this purpose. The benefit of this type of assessment is that one can compare the number of correct selections children make for target words to the number expected by chance, or to performance on a set of control words matched for difficulty. However, this type of measure can provide only limited information about the nature of the learning that has taken place. Correct performance on a forced-choice task requires only a gist understanding of a word's meaning; a child might succeed on such a task on the basis of a rather sketchy representation of a word's semantics, or even a vague notion of the contexts in which a word is *not* appropriate. A word might more reasonably be said to be "known" if it is stored in the lexicon in such a way as to allow the child to use it in their expressive and receptive language.

Other work in this field has assessed learning by asking participants to provide a synonym or definition of the target vocabulary (e.g., Dickinson, 1984; Steele et al., 2012). The requirement to produce an appropriate definition provides a more conservative test of word knowledge than picture selection, as it challenges the child to retrieve the semantic information stored alongside the word's lexical entry. Success at such a task would not be supported by a partial representation of a word's meaning, as it could

in a forced-choice task. However, the ability to produce a suitable definition or synonym also depends on expressive language competence; the full extent of the child's semantic representation of a word might therefore not be evident from their response. As no single measure can provide a comprehensive picture of the lexical representation a child holds for a word, Dockrell et al. (2007) propose that children's learning should be investigated using multiple assessments of word knowledge.

One approach to providing a comprehensive picture of children's learning is to probe their awareness of the newly-acquired word's semantic properties through a graduated or "dynamic" assessment method (Gutiérrez-Clellen and Peña, 2001). For example, to test children's understanding of vocabulary encountered while reading stories, Steele et al. (2012) first asked participants to define the new words; if unsuccessful, the child was given a contextual clue in the form of a sentence containing the word taken from the story, and then asked to define the word again. If the child was still unable to offer a suitable definition, they were given a forced-choice comprehension task, in which the correct definition was listed among four possible answers.

Assessing whether a word has been acquired is more complex than establishing whether its meaning is known, however. When a new item is entered into the lexicon, it is not only the word's semantics that are stored, but also its phonology, syntactic role, pragmatic uses and, as the child becomes literate, its orthography. Very few studies have probed whether children learn a word's syntactic properties when they hear the word in a story context. One exception was reported by Dickinson (1984), who explored 6- and 11-year-olds' ability to learn new words that they heard in conversations or stories or were explicitly taught. There were four components to the test phase: a "word recognition" task, a definition task, a comprehension test and a syntactic judgment task, the last of which required participants to distinguish correct uses of the newly-learned vocabulary from instances where the word was used as an inappropriate part of speech. The younger group's performance on the word recognition and comprehension tests demonstrated that they had acquired at least a partial representation of the meanings of the words they had encountered in stories. However, age differences were seen in children's ability to produce appropriate definitions and identify syntactically-appropriate usages of words, with only the older group succeeding on these tasks.

The current study builds on this previous work by exploring the nature of the representations young school-aged children form for new high-level vocabulary encountered while listening to stories. As in Wilkinson and Houston-Price (2013), the new vocabulary was introduced through repeated readings of a storybook by class teachers at school. Children listened to the same story three times, once a week for 3 weeks. The story contained nine new words, selected to be well beyond the vocabulary level expected for this age group and, to optimize learning, a definition was provided for each new word at its first mention in the story. In order to explore how easily words from different classes are acquired, the target vocabulary included nouns, verbs and adjectives. We assessed children's learning in three ways. As in Wilkinson and Houston-Price (2013), we conducted a forced-choice comprehension test using standardized vocabulary test picture cards, to establish whether the child had acquired at least a gist understanding of each word's meaning. Children were then asked to provide a definition of each target word, which we considered to provide a more stringent test of their understanding of the word's meaning. Finally, we included a grammaticality judgment task similar to that employed by Dickinson (1984), to assess the child's awareness of the new words' syntactic roles. The forced-choice comprehension task was always completed first; as the easiest of the three tasks, we anticipated that this would help children remain motivated to complete the remaining tasks. The grammaticality judgment task was always completed last, so that, if children were able to glean anything of the semantics of the words from their usage in this task, this would not affect their performance on the two comprehension tasks. We hypothesized that children would show greater knowledge of the target vocabulary than of a matched set of control words in all three tasks, demonstrating that they had incorporated both semantic and syntactic properties of the words into their lexicon. We expected that the older group would perform significantly better than the younger group on the definition production and syntactic awareness tasks.

METHODS

PARTICIPANTS

One hundred and forty-eight children were recruited from 13 classes at three primary schools in the South of England. Two children declined to participate in all tests of their word knowledge and the data from a child with a genetic disorder were excluded from analyses. Remaining participants were 75 children in 6 Reception classes (mean age = 4 years, 9 ms; range = 4 years 3 ms—5 years 4 ms; 41 boys; henceforth "the 4-year-old group") and 70 children in 7 Year 2 classes (mean age = 6 years 9 ms, range = 6 years 3 ms—7 years 4 ms; 32 boys; henceforth "the 6-year-old group"). The children's 13 class teachers, who were all native English speakers, also participated in the study. Teachers confirmed that listening to stories was a daily occurrence for the children in their classrooms.

MATERIALS

Target vocabulary

Three lists of words—Difficult Word List 1, Difficult Word List 2 and Easy words—were constructed from the test words used in the British Picture Vocabulary Scale 3rd Edition (BPVS-III; Dunn et al., 2009), so that each list comprised three nouns, three verbs, and three adjectives (see Appendix A). The words in the two difficult word lists were randomly selected (without replacement) from words of the relevant classes in sets 7–10 of the BPVS-III; these sets are suitable for testing the vocabulary knowledge of children aged from 9 to 14+ years and were expected to be largely unfamiliar to our participants. The assignment of the two lists as target and control words was counterbalanced so that approximately half of the children were trained on Difficult Word List 1 and half were trained on Difficult Word List 2; the list that was not selected to be trained provided the control words for each child. Easy words were selected from sets 1 and 2 of the BPVS-III (with the exception of one word taken

from set 6, due to the lack of adjectives in the test's lower sets). BPVS-III sets 1 and 2 are suitable for testing the vocabulary knowledge of children aged between 2 and 4 years and were expected to be known by our participants. Easy words were included to motivate children to complete the tasks, and to enable us to check that children understood the requirements of each task.

Stories

A story was constructed to introduce the vocabulary in each of the difficult word lists. *Jade and Riley's Trip to the Zoo* included the words in Difficult Word List 1, while *Charlie's First Holiday* included the words in Difficult Word List 2. Stories were approximately matched in length and style (1227 and 1263 words respectively; for samples, see Appendix B). Target words were heard three times within the relevant story in a distributed and pseudo-random order, as required to create a coherent narrative. On the first occasion each word was heard, it was accompanied by a dictionary definition of the word taken from the Oxford Children's Dictionary (Allen, 2003) or Oxford Junior Dictionary (Dignen, 2003). Stories were printed on a piece of A3 card with a single picture on the back for children to look at while they were listening; the pictures did not illustrate the target vocabulary.

Test materials

Standard BPVS-III (Dunn et al., 2009) test cards were used to assess children's comprehension of the words in the three lists. Each test card displayed four pictures, one representing the target word. For the grammaticality judgment task, a syntactically-correct and syntactically-incorrect sentence was created for each word in the three lists. Sentences were short and simple and were unrelated in their content to the stories in which they had been heard. The syntactically-incorrect sentences were generated by presenting the target word as an inappropriate part of speech, following Dickinson (1984). For example, when a noun or adjective was used as a verb, this was indicated by the addition of the regular past tense ending. If a verb or adjective was used as a noun, it was pluralized, and when nouns or verbs were used as adjectives, they were inserted between the determiner and noun in a noun phrase construction (see Appendix C).

PROCEDURE

Listening phase

Each class was assigned to listen to one of the two stories, with the assignment counterbalanced within each school and year group; 3 Reception classes and 3 Year 2 classes heard the story containing the vocabulary in Difficult Word List 1, while 3 Reception and 4 Year 2 classes heard the story containing the vocabulary in Difficult Word List 2. Class teachers read the assigned story to their whole class during their usual story time once a week for 3 consecutive weeks. Children were able to see the picture on the back of the story card while it was read. Teachers were instructed to read the story in the same way they would usually read to their class during regular story time activities, but were asked to avoid providing any information about the vocabulary or content of the story other than that given in the script. A researcher was present at the first reading of each story to ensure that teachers understood and followed the instructions provided. At the end of the reading period, teachers confirmed that they had read the stories as instructed and had been able to avoid answering any questions children posed about the stories.

Test phase

Within 1 week of the final reading of the story, a researcher assessed children's knowledge of the new vocabulary. Testing was completed individually in a quiet area away from the classroom. Children completed the three tasks in a fixed order: the forced-choice comprehension task, followed by the definition production task and the grammaticality judgment task. Each task assessed children's knowledge of 27 words: the nine difficult "target" words contained in the story to which the child had been exposed; the nine difficult "control" words contained in the story to which the child had not been exposed; and the nine easy words, which the child was expected to know. Each child was assigned to one of four randomly-generated orderings of the 27 words, and all three tests were conducted in this order.

Forced-choice comprehension task

Children were presented with the relevant BPVS-III test card for each word and were asked to point to the picture that matched the corresponding test word. Responses were coded as either correct or incorrect.

Definition production task

Children were verbally presented with one test word at a time and were asked to say what they thought the word meant. If the child said they did not know, they were asked to guess and, if a partially correct response was given, the child was asked if they knew anything else about the word. Responses were recorded and later coded as either correct or incorrect by two independent researchers, on the basis of their similarity to the word's dictionary definition and the general sense of the child's response. Discrepancies between coders were discussed and agreement was reached in all cases.

Grammaticality judgment task

Children were introduced to two identical finger puppets who "sometimes say things in the right way, and sometimes say things in a silly way." The researcher then produced the two sentences containing each target word as if one sentence was spoken by each puppet. One sentence in each pair was grammatically appropriate, the other grammatically inappropriate (see Appendix C). The child was asked to indicate which puppet was "right" and which was "silly" in each case. The puppet producing the grammatical sentence was randomly assigned on each trial. Children's responses to each trial were coded as either correct or incorrect.

On completion of each task, the child was offered a sticker of their choice as a reward and to provide a short break. The entire test session lasted around 20 min.

RESULTS

All 145 participants completed the forced-choice comprehension task. Two children failed to complete the definition production task (both 4-year-old girls) and nine children failed to complete

the grammaticality judgment task (eight 4-year-olds, 2 girls and 6 boys; one 6-year-old girl). These children's data were included in analyses of the tasks they completed.

Preliminary analyses confirmed that very similar patterns of performance were shown by the children who listened to each of the two stories. We therefore collapsed the data across book group in our primary analyses of performance on each task, but we report any notable differences in the performance of the children who heard the two stories where these occurred.

FORCED-CHOICE COMPREHENSION TASK

Table 1 presents the mean number of correct responses for each set of words in the comprehension task. For the Easy words, performance was at ceiling and significantly above the chance value of 2.25 (the value expected if children had chosen randomly from the four picture choices for each of the nine words tested) in both age groups [4-year-olds: $t_{(74)} = 67.6$, $p < 0.001$, Cohen's $d = 15.72$; 6-year-olds: $t_{(69)} = 132.3$, $p < 0.001$, Cohen's $d = 31.85$], demonstrating that children understood the requirements of the task.

To establish whether children in each age group had learned the meanings of the target vocabulary, a 2 (Age: 4-year-olds vs. 6-year-olds) × 2 (Training: Target vs. Control words) mixed ANOVA was conducted on children's total scores. There was a main effect of Age, $F_{(1, 143)} = 73.2$, $p < 0.001$, partial eta squared = 0.34; older children responded correctly to more words than younger children. There was also a main effect of Training, $F_{(1, 143)} = 105.5$, $p < 0.001$, partial eta squared = 0.43; children responded correctly to more target words than control words, showing that they had learned something about the meaning of the words while listening to the stories. The Age × Training interaction failed to reach significance, $F_{(1, 143)} = 3.63$, $p = 0.059$, partial eta squared = 0.03, showing that the two age groups benefited similarly from listening to the stories, according to this measure.

Word class (noun, verb, or adjective) was not included as a factor in the ANOVA. As the words in each class were not matched for their psycholinguistic properties (length, imageability, frequency, etc), we considered that it would be inappropriate to directly compare children's learning of the words in each class in order to draw conclusions about possible differences in children's ability to learn specific word types. However, to explore whether the learning children showed for words as a whole was also true of each individual word class, we compared children's performance on the target and control words of each word class separately. All comparisons were significant. Children in both age groups produced more correct responses to target words than control words, whether these were nouns [4-year-olds: $t_{(74)} = 7.96$, $p < 0.001$, partial eta squared = 0.46; 6-year-olds: $t_{(69)} = 4.32$, $p < 0.001$, partial eta squared = 0.21], verbs [4-year-olds: $t_{(74)} = 5.02$, $p < 0.001$, partial eta squared = 0.25; 6-year-olds: $t_{(69)} = 3.58$, $p = 0.001$, partial eta squared = 0.16] or adjectives [4-year-olds: $t_{(74)} = 3.33$, $p = 0.001$, partial eta squared = 0.13; 6-year-olds: $t_{(69)} = 2.94$, $p = 0.004$, partial eta squared = 0.11].

Finally, when we included Book Group as a factor in our overall analysis of variance, there was a weak interaction between Book Group, Age and Training, $F_{(1, 141)} = 5.63$, $p = 0.019$, partial eta squared = 0.04. *Post-hoc* analyses revealed that, while the learning shown by the younger group (calculated as the difference in their performance on target and control words) was equivalent for the two Book Groups, $F_{(1, 73)} = 0.85$, $p = 0.36$, partial eta squared = 0.01, the older group who heard the story containing Difficult Word List 2 showed greater learning than children who heard the story containing Difficult Word List 1, $F_{(1, 68)} = 5.74$, $p = 0.019$, partial eta squared = 0.08. However, importantly, children in both Book Groups showed large, significant differences in their scores for target and control words at both ages (all ps < 0.006), confirming that the general pattern of learning reported above was true, regardless of the specific story heard.

The results of the comprehension task therefore demonstrate that listening to stories containing difficult vocabulary enabled children to select the correct representations of the target words from a choice of four pictures. Learning was equivalent for the two age groups and evident for all three word types tested.

DEFINITION PRODUCTION TASK

Table 2 presents the mean number of appropriate definitions provided for each set of words. For Easy words, performance was again at ceiling for the older group and close to ceiling for the younger group; in each case, children produced appropriate definitions for around 8 of the 9 words in this set, showing that they understood the task's requirements.

To explore children's ability to produce appropriate definitions for the more difficult word sets, a 2 (Age: 4-year-olds vs. 6-year-olds) × 2 (Training: Target vs. Control words) mixed ANOVA was conducted on children's total scores for this task. Results mirrored those reported above for the forced-choice comprehension task. There was a main effect of Age, $F_{(1, 141)} = 69.9$, $p < 0.001$, partial eta squared = 0.33; older children produced more correct definitions than younger children. There was also a main effect of Training, $F_{(1, 141)} = 202.5$, $p < 0.001$, partial eta squared = 0.59; children produced more appropriate definitions for target words than control words. There was no Age × Training interaction, $F_{(1, 141)} = 0.51$, $p = 0.48$, partial eta squared = 0.00, demonstrating that the two age groups benefited similarly from listening to the stories in terms of their ability to produce appropriate definitions of the new words.

We again compared children's performance on the Target and Control words of each word class separately. All comparisons were significant. Children in both age groups produced more correct definitions of target words than control words, whether these were nouns [4-year-olds: $t_{(72)} = 5.69$, $p < 0.001$, partial eta squared = 0.31; 6-year-olds: $t_{(69)} = 5.60$, $p < 0.001$, partial eta squared = 0.31], verbs [4-year-olds: $t_{(72)} = 5.95$, $p < 0.001$, partial eta squared = 0.33; 6-year-olds: $t_{(69)} = 4.15$, $p < 0.001$, partial eta squared = 0.20) or adjectives [4-year-olds: $t_{(72)} = 5.73$, $p < 0.001$, partial eta squared = 0.31; 6-year-olds: $t_{(69)} = 6.75$, $p < 0.001$, partial eta squared = 0.40].

In this task, performance was affected by the book children had heard. When we included Book Group as a factor in our overall analysis of variance, there was a significant Book Group × Training interaction, $F_{(1, 139)} = 11.4$, $p = 0.008$, partial

Table 1 | Mean number of correct responses to each set of words in the forced-choice comprehension task.

			4- year-olds *N = 75*		6-year-olds *N = 70*		All children *N = 145*	
		***N* words**	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***
Target words (Trained)	Nouns	3	2.00	0.81	2.64	0.57	2.31	0.77
	Verbs	3	1.53	0.95	2.16	1.00	1.83	1.02
	Adjectives	3	1.31	0.82	2.06	0.81	1.67	0.90
	All words	9	4.84	1.89	6.86	1.78	5.81	2.09
Control words (Untrained)	Nouns	3	1.20	0.82	2.17	0.15	1.67	1.01
	Verbs	3	0.80	0.82	1.64	1.01	1.21	1.01
	Adjectives	3	0.91	0.81	1.71	0.92	1.30	0.95
	All words	9	2.91	1.63	5.53	2.23	4.17	2.34
Easy words	Nouns	3	2.88	0.37	2.99	0.12	2.93	0.28
	Verbs	3	2.93	0.25	3.00	0.00	2.97	0.18
	Adjectives	3	2.63	0.49	2.80	0.40	2.71	0.46
	All words	9	8.44	0.79	8.79	0.41	8.61	0.66

Table 2 | Mean number of appropriate definitions provided for each set of words in the definition production task.

			4-year-olds *N = 73*		6-year-olds *N = 70*		All children *N = 143*	
		N words	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***
Target words (Trained)	Nouns	3	1.34	0.97	2.24	0.91	1.78	1.04
	Verbs	3	0.97	1.01	1.89	1.07	1.42	1.13
	Adjectives	3	1.18	1.02	2.14	1.01	1.65	1.12
	All words	9	3.49	2.46	6.27	2.36	4.85	2.78
Control words (Untrained)	Nouns	3	0.64	0.77	1.57	0.94	1.10	0.97
	Verbs	3	0.29	0.59	1.29	1.04	0.78	0.97
	Adjectives	3	0.51	0.71	1.14	0.87	0.82	0.85
	All words	9	1.44	1.51	4.00	2.00	2.69	2.18
Easy words	Nouns	3	2.89	0.36	2.97	0.17	2.93	0.28
	Verbs	3	2.85	0.36	2.99	0.12	2.92	0.28
	Adjectives	3	2.03	0.78	2.54	0.65	2.28	0.76
	All words	9	7.77	1.06	8.50	0.70	8.13	0.97

eta squared = 0.05. *Post-hoc* analyses revealed that children who heard the story containing Difficult Word List 1 showed a greater difference in their performance on target and control words than children who heard the story containing Difficult Word List 2, $F_{(1, 141)} = 7.54$, $p = 0.007$, partial eta squared = 0.05. However, and importantly, children in both Book Groups showed large, significant differences in their ability to define target and control words at both ages (all ps < 0.001), confirming that the general pattern of learning reported above was true regardless of the specific story children heard during the exposure phase.

Thus, listening to stories containing difficult vocabulary enabled children to produce appropriate definitions of the target words. Learning was again equivalent for the two age groups and evident for all three word classes

GRAMMATICALITY JUDGMENT TASK

Table 3 presents the mean proportion of correct responses for each set of words on the grammaticality judgment task. Scores for this task were converted to proportions to acknowledge the differing numbers of target and control word test trials that remained after the test trial for one word was excluded (see Appendix C for further details). One sample *t*-tests confirmed that children in both age groups performed significantly better than the chance value of 0.5 (expected if children chose one of the two puppets randomly on each trial) on the Easy Word trials [4-year-olds: $t_{(66)} = 3.77$, $p < 0.001$, Cohen's $d = 0.93$; 6-year-olds: $t_{(68)} = 16.0$, $p < 0.001$, Cohen's $d = 3.88$), showing that participants in both age groups understood the requirements of the task.

Table 3 | Mean proportion of correct responses for each set of words in the grammaticality judgment task.

		4-year-olds *N = 67*		6-year-olds *N = 69*		All children *N = 136*	
		Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***
Target words (Trained)	Nouns	0.57	0.32	0.87	0.19	0.72	0.30
	Verbs	0.55	0.35	0.75	0.31	0.65	0.34
	Adjectives	0.54	0.34	0.83	0.23	0.68	0.33
	All words	0.56	0.20	0.81	0.17	0.69	0.23
Control words (Untrained)	Nouns	0.59	0.28	0.83	0.21	0.71	0.28
	Verbs	0.53	0.31	0.71	0.30	0.62	0.31
	Adjectives	0.51	0.39	0.76	0.25	0.64	0.30
	All words	0.54	0.18	0.77	0.16	0.66	0.20
Easy words	Nouns	0.56	0.27	0.84	0.23	0.70	0.29
	Verbs	0.60	0.29	0.84	0.22	0.72	0.28
	Adjectives	0.62	0.31	0.83	0.24	0.72	0.30
	All words	0.59	0.20	0.83	0.17	0.71	0.22

Scores on this task were converted to proportions to take account of the differing number of target and control word trials included for different participants (see Appendix C for more details).

To establish whether hearing words in stories supported children in discovering the words' grammatical roles, a 2 (Age: 4-year-olds vs. 6-year-olds) × 2 (Training: Target vs. Control words) mixed Anova was conducted on children's scores for this task. There was a main effect of Age, $F_{(1,\ 134)} = 92.8$, $p < 0.001$, partial eta squared = 0.41; older children produced more correct responses than younger children. There was no main effect of Training, $F_{(1,\ 134)} = 2.66$, $p = 0.11$, partial eta squared = 0.02, suggesting that children did not learn the new words' grammatical roles while they were listening to the stories. This general pattern was corroborated by comparisons of children's scores for the target and control words of each individual word class (all ps > 0.07). The ANOVA also found no Age × Training interaction, $F_{(1,\ 134)} = 1.03$, $p = 0.31$, partial eta squared = 0.01. However, to fully explore our hypothesis that older children would be better able to identify the syntactic category of the words they heard in stories, we conducted planned comparisons of each age group's performance on target and control words in this task. A weak Training effect was shown by the older group, who were better able to identify the correct grammatical usage of the target words than the control words, $t_{(68)} = 2.30$, $p = 0.024$, partial eta squared = 0.07. No effect of Training was shown by the younger group, $t_{(66)} = 0.37$, $p = 0.71$, partial eta squared = 0.002.

To explore whether the lack of a Training effect among the younger group reflected random responding on the difficult word trials of this task (perhaps due to fatigue, as this was the last task to be completed), one sample t-tests compared children's scores to chance (0.5). In both age groups, performance was above chance for both target words [4-year-olds: $t_{(66)} = 2.24$, $p = 0.029$, Cohen's $d = 0.55$; 6-year-olds: $t_{(68)} = 15.5$, $p < 0.001$, Cohen's $d = 3.76$] and control words [4-year-olds: $t_{(66)} = 2.00$, $p = 0.05$, Cohen's $d = 0.49$; 6-year-olds: $t_{(68)} = 14.1$, $p < 0.001$, Cohen's $d = 3.42$]. These results show that children were not responding randomly on this task; at least some of the children in each age group were able to indicate how the difficult vocabulary should be used in sentences. Rather, the lack of a Training effect among the younger group indicates that hearing the target vocabulary in stories did not facilitate this group's performance on this task.

In sum, while children overall showed no learning of the grammatical role of the target vocabulary in this study, the older group showed greater awareness of the appropriate usage of the vocabulary to which they had been exposed than of the matched control words. There were no effects of the specific story to which children had been exposed in this task, and no evidence of learning for any individual word type.

BETWEEN- AND WITHIN-TASK RELATIONSHIPS

To establish the extent to which the three tasks assessed the same or different components of children's learning about the target vocabulary, we first examined the relationships between children's performance on each task. For each task, the "number of words learned" was computed as the difference between the child's scores for target and control words. As we explored the between-task relationships both for all words combined and for individual word classes, and for both children overall and for the two age groups separately, alpha was set at.0125 (.05/4) for these analyses.

When all children and all word types were included in the analysis, there was a significant correlation between the number of words learned in the forced-choice and definition production tasks, $r_{(143)} = 0.31$, $p < 0.001$, suggesting that these were tapping into the same aspects of children's knowledge of the target vocabulary. There was no relationship between the learning shown on the forced-choice and grammaticality judgment tasks, $r_{(136)} = 0.11$, $p = 0.22$. However, performance on the definition production and grammaticality judgment tasks was correlated, $r_{(135)} = 0.25$, $p = 0.003$, showing that those children who had

learned the grammatical use of the target vocabulary were also better able to define these words.

We explored these relationships further by computing the measure of learning for each word class separately. Interestingly, the relationship reported above between the two comprehension tasks was found to be specific to word class. That is, we found correlations between the learning children showed on the forced-choice and definition production tasks for nouns, $r_{(143)} = 0.34$, $p < 0.001$, verbs, $r_{(143)} = 0.43$, $p < 0.001$, and adjectives, $r_{(143)} = 0.25$, $p = 0.002$, and no cross-word class relationships between tasks (all ps > 0.08). Thus, the relationships we observed do not simply reflect the more able children doing better in both tasks. Rather, the picture-selection task and definition production task appear to have tapped into the same aspects of children's knowledge of the target vocabulary, presumably semantic awareness. The correlations between the learning shown on the definition production task and grammaticality judgment task did not meet our adjusted alpha criterion for any individual word class [nouns: $r_{(135)} = 0.16$, $p = 0.057$; verbs: $r_{(135)} = 0.18$, $p = 0.038$; adjectives: $r_{(135)} = 0.13$, $p = 0.13$], but again there were no cross-word class relationships (all ps > 0.2).

When the learning shown by the two age groups was explored separately, some interesting differences were seen in the pattern of between-task relationships. The younger group showed a very strong relationship between their learning on the forced-choice and definition production tasks, $r_{(73)} = 0.51$, $p < 0.001$. As for children overall, this relationship was underpinned by strong word class-specific relationships [nouns: $r_{(73)} = 0.44$, $p < 0.001$; verbs: $r_{(73)} = 0.34$, $p = 0.004$; adjectives: $r_{(73)} = 0.43$, $p < 0.001$). The younger group revealed no relationships between their performance on the definition production and grammaticality judgment task, either overall or for any individual word class (all ps > 0.06). In contrast, the older group showed no relationship between their overall scores for the two comprehension tasks, $r_{(70)} = 0.11$, $p = 0.36$, and only a weak relationship between their scores for the definition production and grammaticality judgment tasks, which did not meet our criterion for alpha, $r_{(69)} = 0.28$, $p = 0.02$. However, when words were separated by word class, relationships were found between the older group's learning of verbs in the forced-choice and definition production tasks, $r_{(70)} = 0.51$, $p < 0.001$, and in the definition production and grammaticality judgment tasks, $r_{(69)} = 0.33$, $p = 0.006$. No significant cross-word class relationships were shown by either age group.

Given the word-class specificity of the between-task relationships reported above—whereby performance on the words of any word class in one task was only ever correlated with performance on the same word class in another task—we went on to examine whether there were any within-task relationships between performance on the three word categories included in our study. As we examined the within-task correlations both for children overall and for each age group separately we set our alpha criterion at 0.025 (0.05/2) for these analyses. There were no positive cross-word class correlations in performance on any of the three tasks, either for children overall or for either individual age group (all ps > 0.05). Indeed, the only correlation that met our criterion for alpha was a negative relationship between children's performance on verbs and adjectives in the grammaticality judgment task, $r_{(136)} = -0.21$, $p = 0.02$.

In sum, performance on the two comprehension tasks was strongly related, especially among the younger participants. In contrast, performance on the picture-selection task and grammaticality judgment task was unrelated, suggesting that these assess entirely independent components of word knowledge, likely to be semantic and syntactic knowledge respectively. The ability to produce definitions of newly-learned words was related to grammatical awareness in children as a whole, but the relationship was most evident in the older group's ability to define and recognize the appropriate usage of verbs. The systematic lack of cross- word class relationships demonstrates that children's ability to learn one word class while listening to stories was, surprisingly, unrelated to their ability to learn other word classes.

DISCUSSION

This study assessed the learning children showed for the vocabulary they had encountered while listening to stories using three tests of word knowledge. In a forced-choice comprehension task, children were asked to select the picture that represented each word from a set of four candidate pictures. As hypothesized, children in both age groups (4- and 6-year-olds) gave the correct response significantly more often for exposed words than for a matched set of control words, with no difference between the age groups. Recall that children were not provided with pictures to support their story comprehension during the listening phase; their success at the forced-choice task therefore indicates that hearing the words (and their accompanying definitions) in stories supported the construction of lexical representations that were sufficient to identify the relevant pictorial representation for each word (or, possibly, to rule out the pictures that were unrelated to the words).

The same pattern was seen in the definition production task, which required children to explain the meanings of the newly-learned vocabulary; more appropriate definitions were given for target words than control words. Hearing new words (and their accompanying definitions) in stories therefore enabled the children to make a reasonable attempt at defining their meanings, suggesting that the lexical representations they had established for these words comprised more than just a gist interpretation. It is worth noting that, in contrast to the forced-choice task, performance on the definition task would have been directly supported by the manner of presentation of the target vocabulary in the stories; a child could have succeeded at this task by simply recalling the definitions that had been provided within the story. We would consider such an ability to constitute a form of word learning. When children were listening to the stories, they were not expecting to be tested on the meaning of the new vocabulary these contained; that they remembered the definitions included in the stories, and could produce these as appropriate when they were later asked to define each word, in our view, provides a clear indication that learning had taken place. Contrary to our expectations, the two age groups performed equally well on this more challenging comprehension task (c.f. Dickinson, 1984). Thus, from the earliest

school years, children are able to ascertain sufficient detail of the meanings of words they encounter in stories to be able to describe what these mean, even for vocabulary items considerably beyond the level expected for their age group. These findings corroborate previous evidence that children are able to acquire the meanings of difficult vocabulary items when listening to stories that provide semantic support for words' meanings (Elley, 1989; Sénéchal et al., 1995; Brett et al., 1996; Sénéchal, 1997; Reese and Cox, 1999; Penno et al., 2002; Justice et al., 2005; Biemiller and Boote, 2006; Beck and McKeown, 2007; Wilkinson and Houston-Price, 2013), and extend this evidence to a younger group of 4-year-olds who have only recently started school.

We also assessed children's ability to recognize the appropriate grammatical usage of the exposed vocabulary through a forced-choice puppet task. Each word was placed into two sentence frames containing no semantic clues to the word's meaning, where one frame was syntactically appropriate, the other syntactically inappropriate; children were asked to indicate which puppet said it "right" and which was "silly." As a whole, children identified the correct uses of the target words no better than the correct uses of the control words, with performance on both word lists superior to chance. One possible explanation of these findings is that children had heard the words in the difficult word lists before, even if they did not know what they meant. If grammatical class is the first piece of information children acquire about a word when it is heard in a sentence context, they might have already been aware of the syntactic roles of the difficult vocabulary we set out to teach them. However, performance was not at ceiling on this task, leaving plenty of room for learning to result from the additional exposure children gained when they heard the words in the stories. *Post-hoc* analyses suggested that the older group did, in fact, perform better on target word trials than control word trials, suggesting that at least some 6-year-old children had incorporated some information about the exposed words' syntactic roles into their lexical representations for these items (c.f. Dickinson, 1984).

Additional analyses explored whether the three tasks that formed our assessment battery indexed the same or different components of children's knowledge of the target vocabulary. There was no shared variance between children's performance on the forced-choice comprehension task and grammaticality judgment task, confirming that the components of word knowledge addressed by these tasks were entirely independent. Moreover, the lack of relationship between these tasks means that one cannot attribute the positive correlations we observed—between the two comprehension tasks and between the definition production and grammaticality judgment tasks—simply to "brighter" children doing better across the board. Rather, these positive relationships suggest that the picture-selection task and definition task both tapped children's awareness of the semantic properties of the newly-learned vocabulary, while the definition and grammaticality judgment tasks both provided an index of the child's knowledge of the words' syntactic roles. We had included the definition task in our assessment battery as a more challenging test of semantic knowledge than was offered by the picture-selection task, not anticipating that this task might also reflect the child's awareness of the word's syntactic role. However, it makes sense that, in order to produce a reasonable account of what a word means, a child would need to know something about how the word might be used—in other words, its grammatical role. Furthermore, returning to the issue of how the stories might have supported children's performance on the definition task, the relationships found between performance on this task and performance on the other tasks suggest that children were doing more than reeling off rote-learned definitions when asked to explain the target words' meanings. Rather, they were drawing on the same store of semantic and syntactic knowledge that supported their performance on the forced-choice and grammaticality judgment tasks respectively.

The design of our study also allowed us to explore whether the learning of difficult vocabulary in a range of word classes (nouns, verbs, and adjectives) is supported by introducing children to these words in stories. Previous research has reported differential rates of learning of different word classes when children listen to stories or instructional videos, such that nouns are acquired more easily than other word types (Robbins and Ehri, 1994; Ard and Beverly, 2004; Dockrell et al., 2007). For example, Dockrell et al. (2007) observed a "noun bias" in 4- to 7-year-old children's ability to produce scientific terms after children had been introduced to nouns, verbs and adjectives in an educational video. A similar pattern was observed in Dockrell et al.'s measures of comprehension; while children showed equivalent levels of understanding of the nouns and adjectives they had encountered, performance on these word classes was superior to their understanding of the verbs. A "noun bias" is also seen in early language development, when nouns dominate over verbs, adjectives and other word classes in infants' vocabularies (Goldin-Meadow et al., 1976; Waxman and Kosowski, 1990). Alternative explanations exist for this phenomenon; while some highlight the conceptual difficulty of representing properties of objects or relationships between objects compared to representing objects themselves (Gentner, 1978; Spelke, 1994), others point to the relative complexity of the lexical representations we hold for nouns, verbs and adjectives (Gillette et al., 1999).

The current study was unable to directly compare children's learning of words in different word classes, as we did not attempt to match the words of each type for properties that might have impacted on the ease with which they were learned. However, the results were clear in establishing that the sharing of stories can be used to introduce the full range of word types into children's lexicons. Children in both age groups showed a greater awareness of the meanings of exposed words in all three word classes in both the picture-selection and definition production tasks. Whether it is as easy to acquire grammatical knowledge about the three word types is less clear. While hearing the target vocabulary in the story context appeared to provide some support to 6-year-olds in judging whether the words were used in appropriate syntactic frames, their learning was not robust enough to be shown for any individual word class.

A particularly surprising finding in relation to children's learning of the words in different word classes was the lack of

relationship between them. While we found systematic patterns of between-task correlations within each word class (such that picture-selection performance for nouns was strongly correlated with definition production performance for nouns, e.g.), there were no within- or between-task relationships that crossed word class, for children overall or either age group. Children's ability to learn the meanings of words in one syntactic category was, in this study, entirely unrelated to their ability to learn words in another. This finding appears to contradict the view that some children are simply better at acquiring new vocabulary (e.g., Daneman, 1988; Biemiller and Slonim, 2001). Rather, the results of the current study suggest that the learning of words in different classes may be supported by a distinct set of mechanisms or strategies.

Closer examination of the within-class correlations between the three assessments in our test battery provides some insight into the mechanisms that might support the representation of different word types. While the younger group showed within-class relationships between their performance on the two comprehension tasks for all three word types, the older children only showed such a relationship in assessments of their understanding of verbs. Similarly, the older group showed a relationship between their performance on the definition production and grammaticality judgment tasks only when they were assessed on their knowledge of verbs. If this pattern of relationships is interpreted in terms of the knowledge children were able to call upon when asked to produce a definition of each word, as discussed above, then it would appear that the younger children drew on specific semantic knowledge of the words in each class, as indexed by their scores for these items in the picture-selection task. In contrast, and only when they were asked to define verbs, the older group appear to have drawn on both their semantic knowledge of these words and their awareness of the words' syntactic roles, as indexed by children's scores on the grammaticality judgment task. This account suggests that syntactic information plays a central role in supporting children's understanding of verbs. Such an interpretation is congruent with the view that verbs are "special" because they define the structure of the sentences in which they appear (Levin, 1993), and that syntactic information is fundamental to the representation of this word class in the lexicon (Garrett, 1990). Indeed, some accounts claim that, when a verb is retrieved for production purposes, information about the sentence frames in which it might be used is automatically retrieved at the same time (Pickering and Branigan, 1998). Thus, it is feasible that the older group, for whom some evidence of learning was seen on the grammaticality judgment task, automatically retrieved information about the words' syntactic roles when asked to provide definitions of verbs, but not when they were asked to define nouns or adjectives. Further work is clearly needed to explore these ideas.

In addition to furthering our understanding of the components of the knowledge children acquire while listening to stories, and how these may differ for the vocabulary in different word classes, this work has clear implications for the way in which vocabulary instruction is delivered in educational contexts. A previous meta-analysis of research in this field found that teacher-delivered interventions tend to produce smaller effects sizes than experimenter-led studies of vocabulary learning (Mol et al., 2009) and the authors note the importance of addressing this difference in order to "bridge the gap between research and practice" (p. 1000). The results of the current study confirm that teacher-delivered stories to whole classes of children can effectively introduce difficult new vocabulary of a range of word types. Given teachers' established willingness to engage in shared story sessions as part of the literacy curriculum, an extension of this practice is likely to be both affordable and practicable for schools to deliver. To this end, we encourage the development of challenging but engaging reading materials that incorporate the high-level vocabulary that children may be missing. It is likely that, in addition to supporting the language development of children whose home environments might be considered linguistically impoverished, this practice would benefit the growing numbers of children in our schools for whom the language of instruction is not their first language. In a study with young primary school children, Biemiller and Boote (2006) found that both monolingual children and children learning English as an additional language (EAL) benefited from repeated storybook readings accompanied by explanations of the target vocabulary. Collins (2010) recently reported that the same factors support the acquisition of sophisticated vocabulary knowledge in EAL preschoolers.

Coyne et al. (2012) recently proposed an intensive 18-week programme of vocabulary instruction that teachers might deliver in two half-hour slots per week. The intervention aims to support children's learning of 54 "Tier 2" vocabulary items (Beck and McKeown, 2007) that are unlikely to be learned without support, and is based on the principles of repeated exposure to the target vocabulary through shared stories and explicit definition of words as they are encountered. Coyne et al. advise practitioners not to shy away from providing explicit vocabulary instruction due to concerns that any gains achieved will be insignificant in light of the large number of words children need to learn (Anderson and Nagy, 1992). Just as a snowball can cause an avalanche, the more words a child knows, the easier they will find it to learn further words (Stanovich, 1986; Biemiller and Slonim, 2001). While a child may not need "funambulist" in their lexicon unless they are planning to join the circus, the benefits of extending a child's word knowledge to a level beyond that needed for everyday conversation are indisputable (Cunningham and Stanovich, 1997; Storch and Whitehurst, 2002; Chall and Jacobs, 2003; Dickinson et al., 2003).

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APPENDIX A

WORD LISTS AND THE BPVS-III WORD SET FROM WHICH WORDS WERE DRAWN (IN BRACKETS)

Word Class	Difficult word list 1	Difficult word list 2	Easy words
Noun	Aquarium (9)	Luggage (9)	Ball (1)
Noun	Bouquet (10)	Antlers (8)	Duck (1)
Noun	Hyena (7)	Valley (8)	Mouth (1)
Verb	Snarling (9)	Applauding (9)	Swimming (1)
Verb	Departing (10)	Harvesting (8)	Drinking (1)
Verb	Grooming (7)	Greeting (8)	Jumping (1)
Adjective	Exhausted (9)	Inflated (9)	Rough (6)
Adjective	Canine (10)	Adjustable (8)	Happy (2)
Adjective	Tubular (7)	Tropical (8)	Empty (2)

APPENDIX B

SAMPLES FROM THE STORIES USED TO INTRODUCE THE TARGET VOCABULARY

Sample from *Jade and Riley's Trip to the Zoo* (Difficult word list 1)

Jade was excited about seeing the monkeys and ran to their cage. Two monkeys were picking at each other's fur. Dad told Jade they were **grooming** each other. **Grooming means to clean and brush**. Jade thought the monkeys seemed to enjoy this. Riley liked the monkeys because they were having fun and none of them were **snarling** at him. Mum and Dad were feeling **exhausted**. **Exhausted means very tired**. So they decided it was a good time to have their picnic, and they sat down for their lunch. It was a special day out so Mum brought Riley and Jade some sweeties for after lunch, as a treat. These were their favourite, little circles of chocolate in a **tubular** shaped packet just like the tunnel they had walked through earlier... but much smaller! "Smarties!" shouted Jade. "My favourite" said Riley.

Sample from *Charlie's First Holiday* (Difficult word list 2)

Then they had to wait for ages in the waiting room. Charlie began to think about what Spain was like. "Is Spain a **tropical** country?" he asked. **A tropical place has a very hot, wet climate**. "No Charlie, Spain is hot but it doesn't rain much," said Mum. While they were waiting for their flight, a man came and sat next to them wearing a funny hat with **antlers** on it. **Antlers are the branched horns of a deer**. At last, there was an announcement calling them to get on the aeroplane. Charlie was so excited. Two air stewardesses were **greeting** all the passengers and checking tickets as they got on the plane. One of them told Charlie that he couldn't keep his **inflated** crocodile blown up otherwise Croccy would need his own seat, and then they would have to buy him another ticket! So Charlie and his brother quickly squashed him flat and Mum put him in her bag. "See you on the other side, Croccy," whispered Charlie.

APPENDIX C

SENTENCES USED IN THE GRAMMATICALITY JUDGMENT TASK

	Grammatically correct	Grammatically incorrect
Difficult word list 1	The **hyena** went hunting to feed his family	The **hyena** man went hunting to feed his family
	Mum and Dad went to the **aquarium**	Mum and Dad **aquariumed**
	Frankie bought his girlfriend a **bouquet**	Frankie **bouqueted** his girlfriend
	The cat sat by the fire **grooming** her kittens	The **grooming** fire warmed the cat
	On holiday in the jungle Jack saw a lion **snarling**	Jack saw **snarlings** in the jungle
	Whilst **departing** from the park the family laughed	At the park the family saw the **departings** laughing
	Mum had lots of **tubular** shaped cushions on her bed	Mum had lots of **tubulars** and cushions on her bed
	After a long day at work Dad was **exhausted**	The **exhausteds** had had a long day at work
	The **canine** animals walked through the forest	The animals **canined** through the forest
Difficult word list 2	Old man Jim lived in the **valley**	The **valley** door of Jim's house was red
	Father Christmas' reindeers have **antlers**	Father Christmas' reindeers **antlered** through the sky
	Sophie took lots of **luggage** to Canada with her	The **luggage** plane flew Sophie to Canada
	Granny gave Karen a warm **greeting** when she got to her house*	The **greeting** house was where Granny lived
	The farmers were **harvesting** in the bright warm sunshine	The **harvesting** vegetables were collected by the farmer
	As the play finished the crowd were **applauding**	As the play finished the **applaudings** cheered
	Dad changed the **adjustable** volume on the radio	Dad **adjustabled** the volume on the radio
	Mrs Magoo lives in a **tropical** country	Mrs Magoo **tropicalled** to a different country
	At the birthday party there were lots of **inflated** balloons	At the birthday party there were lots of **inflateds**
Easy words	Timmy and Ben played catch with their shiny new **ball**	Timmy and Ben **balled** in the park
	Gemma fed bread to her pet **duck**	The **duck** pet asked Gemma for food
	The sleepy hippo yawned with his big **mouth**	The **mouth** hippo felt sleepy
	Harry liked **jumping** on his trampoline	The **jumpings** liked the trampoline
	Caitlin loved **drinking** milkshakes	The **drinkings** loved making milkshakes
	Barry likes to go **swimming**	The **swimming** children splashed in the pool
	Roya drank all of her milk and now her glass was **empty**	The **empties** drank all of their milk
	The **happy** elephant twizzled his trunk	The elephant **happied** back to his herd
	The **rough** ground in the garden hurt Grandad's feet	Grandad **roughed** in the garden

** "Greeting" was erroneously used as a noun in the "grammatically correct" sentence for this word, when it had been used as a verb in the story. The test trial for this word was therefore excluded from analyses of children's learning on this task. Note that "greeting" was a target word for some children and a control word for others (depending on the story they heard).*

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Goodnight book: sleep consolidation improves word learning via storybooks

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Reading the same storybooks repeatedly helps preschool children learn words. In addition, sleeping shortly after learning also facilitates memory consolidation and aids learning in older children and adults. The current study explored how sleep promotes word learning in preschool children using a shared storybook reading task. Children were either read the same story repeatedly or different stories and either napped after the stories or remained awake. Children's word retention were tested 2.5 h later, 24 h later, and 7 days later. Results demonstrate strong, persistent effects for both repeated readings and sleep consolidation on young children's word learning. A key finding is that children who read different stories before napping learned words as well as children who had the advantage of hearing the same story. In contrast, children who read different stories and remained awake never caught up to their peers on later word learning tests. Implications for educational practices are discussed.

Keywords: word learning, sleep, shared storybook reading, language acquisition, memory consolidation

INTRODUCTION

Young children frequently ask for a favorite story to be read repeatedly (Sulzby, 1985)—particularly at bedtime (Sénéchal and LeFevre, 2001; Burke et al., 2004). This may be highly beneficial because repeatedly reading the same stories facilitates word learning (Sénéchal, 1997; Horst et al., 2011; McLeod and McDade, 2011; Wilkinson and Houston-Price, 2013) and reading stories can reduce the length of the bedtime routine (Field and Hernandez-Reif, 2001). Recent research also demonstrates a profound effect of sleep consolidation on word recall in adults (e.g., Dumay and Gaskell, 2012) and school-aged children (e.g., Gais et al., 2006; Brown et al., 2012). In the current study we explore how shared storybook reading immediately before a period of sleep facilitates preschool children's word learning.

SHARED STORYBOOK READING

Shared storybook reading helps young children learn new vocabulary (Hargrave and Sénéchal, 2000; Reese et al., 2010) and promotes later academic success (Whitehurst et al., 1988; Rimm-Kaufman and Pianta, 2000). Preschool children especially benefit when the same stories are read repeatedly (Sénéchal, 1997; Horst et al., 2011; McLeod and McDade, 2011). For example, Sénéchal (1997) tested children either after a single reading of a storybook or after repeated readings of the same storybook. Repeated readings increased both expressive and receptive word learning. Recently, McLeod and McDade (2011) explored the effects of repeated readings as well as contextual diversity. Children were tested in one of two conditions. In one condition, children heard a storybook, which contained each novel word once, read three times. In the other condition, children heard a storybook, which contained each novel word in three different contexts, read once. Children who heard the same story repeatedly demonstrated significantly better word learning than children who heard the diverse storybook once. Taken together, these studies demonstrate a clear advantage for reading stories repeatedly. However, the strength of this advantage remains unclear due to the methodological differences between conditions. For example, the amount of time children spent engaged in reading was less for children who only heard one story (see also Horst, 2013, for further review of methodological concerns).

In another recent study, overall storybook exposure was experimentally controlled by reading children either the same stories repeatedly or different stories (Horst et al., 2011). All children heard three stories during each session and had the same exposure to the novel words embedded within the stories. The only difference between conditions was whether the story context remained the same for the three readings or changed with each story reading. Children in the same stories condition learned significantly more novel words over the course of 1 week than children in the different stories condition. The authors argued that children learned more words when read the same stories repeatedly because such contextual repetition reduces the cognitive demands of the task, which, in turn, leads to better long-term learning (see also Horst, 2013).

To further test this explanation, Williams et al. (2011) also read children either the same or different stories; however, they increased the difficulty of the repeated readings condition by repeating the stories across days. Children in both conditions heard three different stories during each session over the course of 1 week. Here the only difference between groups was whether the same three stories were read during each session or whether three new stories were read during each session. Despite increasing the difficulty, children in the same stories condition learned significantly more novel words than children in the different stories condition.

Horst (2013) has argued that children in these studies, as well as others (e.g., Ard and Beverly, 2004; McLeod and McDade, 2011), benefited from contextual repetition, which lowers the cognitive demands of the word learning task and consequently frees up cognitive resources to facilitate encoding of new information. However, encoding is only one stage of memory processing (Diekelmann et al., 2009; Robertson, 2009). For robust word learning to occur, children must also consolidate the new information and retrieve it after a delay (Horst and Samuelson, 2008).

SLEEP CONSOLIDATION

Sleep is a powerful aid in memory consolidation (see Diekelmann et al., 2009, for a review), allowing children and adults to better recall newly encoded information at a later time (Wilhelm et al., 2013). Sleep supports many cognitive functions including learning object locations (Kurdziel et al., 2013), relationships among objects (Lau et al., 2010), and face processing (Mograss et al., 2006). In particular, sleep supports the consolidation of declarative memory (see Ellenbogen et al., 2006, for a review)—the kind of memory involved in recalling new words (Robertson, 2009).

Sleep is most effective if it follows within a few hours of learning to reduce interference of the memory traces (Gais et al., 2006; Diekelmann et al., 2009). Even short naps provide beneficial effects of memory encoding. For example, Lahl et al. (2008) gave adults lists of adjectives to learn before napping or an equivalent period awake. Adults remembered words significantly better after an ultra short nap of only 6 min than after remaining awake for the same amount of time. However, napping for approximately 30 min promoted even better learning.

Naps also facilitate early language acquisition, particularly abstraction (e.g., learning one element predicts another later element as in "See the *cars*? Do you like *them*?"). For example, Gómez et al. (2006) exposed 15-month-old toddlers to an artificial language for 15 min at home before they napped or remained awake. When tested 4 h later in the lab, toddlers who had slept demonstrated an understanding of the abstract structure of the language, but the toddlers who remained awake did not, indicating sleep facilitated abstraction. However, another possible explanation is that toddlers who napped were simply better rested at test. In a follow-up experiment toddlers were exposed to the same language before a regular nap time and tested 24 h later (Hupbach et al., 2009). Again, when toddlers napped shortly after exposure to the language, they learned the general abstract structure, suggesting the original effect found by Gómez et al. (2006) was due to sleep consolidation and not simply being well-rested at test. In another condition, toddlers were familiarized to the artificial language at least 4 h before their next nap and tested 24 h later (Hupbach et al., 2009). When toddlers did not nap shortly after the learning phase they did not learn the abstract structure of the language, suggesting that the benefits of sleep consolidation are strongest if sleep follows shortly after learning (see also Gais et al., 2006; Diekelmann et al., 2009).

Work by Gaskell and colleagues (Dumay and Gaskell, 2007, 2012; Brown et al., 2012; Henderson et al., 2012) also demonstrates a benefit of sleep consolidation on language processing (see also Backhaus et al., 2008). For example, adults incorporate novel pseudo-words into their existing lexicons better if they learn the words in the evening prior to sleeping than if they learn the words in the morning (Dumay and Gaskell, 2007, 2012). A similar result has been found with 9-year-old children (Henderson et al., 2012). In this case, children were randomly assigned to learn new pseudo-words in the early morning or late afternoon. Children who learned the words in the evening prior to sleeping performed significantly better on cued word recall tests and continued to perform well the next day and 1 week later. Children who learned the words in the morning only performed well after they had had their overnight sleep, and then also continued to perform well 1 week later.

A similar effect has also been found by Backhaus et al. (2008) who trained 9–12-year-old children on lists of noun pairs both in the evening before sleep and in the morning. When children learned the words in the evening, they were significantly better at cued recall on both retention tests (the next morning and the next evening) than when they learned the words in the morning. In both conditions, children's performance improved following a period of sleep. That is, when children learned the list before a period of wakefulness, their recall did improve after their normal overnight sleep. Similarly, 7-year-old children are significantly more accurate on cued recall tests of newly learned pseudo-words after a longer retention interval including a period of overnight sleep than after a shorter retention interval of only 3–4 h that does not include sleep (Brown et al., 2012). Taken together, these studies present compelling evidence that sleep promotes memory consolidation in word learning studies for both older children and adults.

THE CURRENT STUDY

In the current study we explored how sleep promotes word learning in preschool children using a shared storybook reading task. Half of the children habitually took afternoon naps and half of the children did not. Note that preschool children who habitually nap and those who do not habitually nap sleep for equivalent amounts of time within 24-h periods because those who do not nap sleep for longer at night (Ward et al., 2008; Lam et al., 2011). In addition, children were either read the same story three times or were read three different stories (for a similar method see Horst et al., 2011). Each story contained two novel name-object pairs and all children received the same exposure to each name-object pair (this is in line with the number of words children this age can learn within a given day, see Bion et al., 2013, and the number of words children can learn from storybooks, see Biemiller and Boote, 2006). Children's word learning was tested immediately, after their naps (nap conditions) or after the same amount of time awake (no nap conditions), as well as after their regular overnight sleep (24 h later) and after 7 days. To extend the previous research on repeated readings, we also included a ratings task to better understand the impact of repeated readings on children's enjoyment. Finally, we included plot comprehension questions as a control to ensure children were listening to the stories.

Based on previous research (e.g., Horst et al., 2011; Williams et al., 2011; Wilkinson and Houston-Price, 2013), we expect that children in the same stories conditions will demonstrate better word learning than children in the different stories conditions.

Importantly, if sleep consolidation promotes word learning, then children who nap after hearing the stories should perform better than children who do not nap and performance should generally improve after overnight sleep. A critical test for the benefit of sleep consolidation on word learning will be the performance of the children who hear different stories and then nap. Learning words from different stories is challenging (e.g., Horst et al., 2011); however, sleep consolidation is highly effective if it occurs shortly after learning (Gais et al., 2006; Diekelmann et al., 2009; Hupbach et al., 2009). If sleep consolidation has a strong influence on word learning, then these children should later perform at levels similar to children who had the advantage of hearing the same story repeatedly. In contrast, if sleep consolidation has little influence on word learning, then both groups of children who hear different stories should perform similarly and we should find no effect of sleep.

METHODS

PARTICIPANTS

Forty-eight 3-year-old children participated. Children were monolingual, British English speakers from primarily white, middle-class families living in an urban area on the English Channel and had no known learning difficulties. Children were recruited through nurseries and preschools. As a thank you, nurseries and pre-schools received book tokens and each child received several stickers. An additional four children were tested but their data not included in the final sample because they failed to cooperate ($n = 1$) or missed the final test due to absence ($n = 3$).

Children were quasi-randomly assigned to four conditions based on whether or not they habitually napped. Half of the children were read the same story and half were read different stories. This resulted in the following groups: same story nap (8 girls, 4 boys, $M = 42$ months, 6 days, $SD = 2$ months, 20 days), same story no nap (5 girls, 7 boys, $M = 41$ months, 26 days, $SD = 3$ months, 14 days), different stories nap (8 girls, 4 boys, $M = 42$ months, 1 day, $SD = 2$ months, 10 days), and different stories no nap (6 girls, 6 boys, $M = 43$ months, 14 days, $SD = 3$ months, 9 days). There was no difference in age between groups, $F_{(3,\ 44)} = 0.71$, $p = 0.55$.

STIMULI

Children were read either one or three short storybooks minimally modified from those created by Horst et al. (2011): *Rosie's Bad Baking Day, The Very Naughty Puppy* and *Nosy Rosie at the Restaurant.* All three stories were compiled into one spiral-bound covered book where they appeared as chapters. For more information on the storybooks see Horst et al. (2011). Throughout each story, two novel objects were each depicted and named four times but were not the focus of the plot: an inverted slingshot that functioned like a hand mixer (*sprock*) and a kinetic wheel that functioned like a rolling pin (*tannin*). The objects appeared twice on their own pages and twice together.

Test stimuli

To test whether children learned the target words, an A4 spiral-bound test booklet with three practice pages and 13 test pages was used. Practice pages included pictures of four different familiar objects (e.g., ball, fish, plane, and car) and test pages included pictures of four novel objects ($M = 4.07 \times 6.43$ cm $SD = 1.25$ cm). Throughout the test pages the novel targets (*sprock*, *tannin*) appeared both individually and together. The other novel objects were novel distractors that the children had not previously seen (see also, Werchan and Gómez, 2014). Picture locations (e.g., top left) were counterbalanced across pages.

PROCEDURE AND DESIGN

Children were tested individually in their normal nursery setting four times within 8 days: immediately after they heard the stories, after a 2.5-h delay (during which time the children who habitually napped took their naps), after a 24-h delay and 7 days after the initial visit, see **Figure 1**. To increase ecological validity and to allow the children to become familiar and comfortable with the experimenter, she spent a week at the nursery before the experiment helping with routine activities and play (see also Dunn et al., 1977; McLeod and McDade, 2011).

Children were read stories and tested individually in a quiet room (either another classroom or a quiet common area). However, because testing took place in a daycare setting, other people and activities could be sometimes heard, reflecting children's typical daytime shared storybook reading experiences. Note, Riley and McGregor (2012) recently manipulated background noise (quiet, moderate white noise) when novel words were introduced to school-aged children. They tested children's novel word comprehension using 4-alternative forced-choice trials with pictures, as we do in the current study. Importantly for the current study, they found no effect of background noise on children's comprehension for novel names, although they did find an effect on children's word production.

Reading phase

During the reading phase, children sat beside the experimenter to ensure the illustrations were easy to see. Children were either read the same story three times or all three different stories once each. Importantly, all children encountered each name-object pair 12 times. Children's questions and comments were neither encouraged nor discouraged (for a similar method see Sénéchal and Cornell, 1993). If the child asked questions the experimenter encouraged the child to return attention to the story (e.g., "let's keep reading and see!") and avoided naming any objects. The order in which children in the different stories conditions heard the stories was counterbalanced across participants using a Latin Square design. All three stories were read across participants in the same story conditions. Children were given a sticker after each reading to keep them engaged in the task as the nursery/preschool setting is otherwise alluring.

Story enjoyment ratings

Children's enjoyment of the stories was examined using a 3-point ratings task (for a similar method rating television programs see Anderson et al., 2000). Immediately after hearing each story, the child was asked to indicate his/her enjoyment of story by giving the experimenter a laminated smiley face card (2′ diameter) from an array. The experimenter asked the child "how much did you

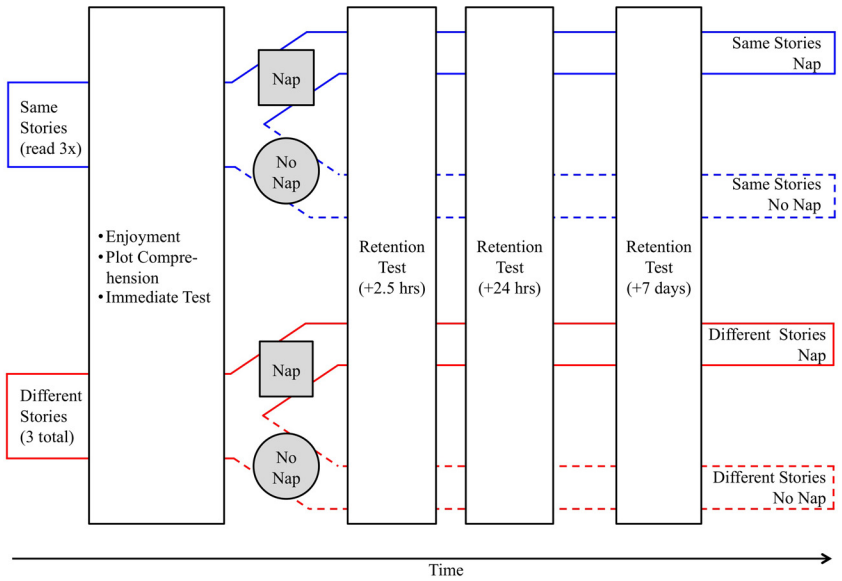

FIGURE 1 | Schematic representation of the experimental design. Children participated in one of four conditions (same story nap, same story no nap, different stories nap, different stories no nap). Children's word recall was tested immediately after reading stories and then children either napped or did not nap. Children's word retention was subsequently tested 2.5 h later, 24 h later, and 7 days later.

enjoy reading this story today?" and set each card on the table, one at a time, explaining what each card represented. For example, "pick this card if you liked the story a lot," or "pick this card if you didn't like the story." The order the cards were set on the table was counterbalanced within and across participants, but "a lot" was always placed on the left, "a little" in the middle and "didn't like" on the right. Finally, after hearing all three stories (or after the third reading of the same story), the experimenter asked the child "how much did you enjoy reading all three stories today?"

Plot comprehension questions

Immediately after the story enjoyment questions nine plot comprehension questions were administered as an additional control to check children were paying attention to the stories in the different stories conditions. The plot comprehension questions were presented as forced-choice questions and both potential answers were words or phrases that had occurred in the relevant story (to ensure answers appeared in the text, the stories were minimally edited from the originals used by Horst et al., 2011). For example, a question for *Rosie's Bad Baking Day* asked "was Rosie's daddy gone a long time or was he quick?" (He was gone a long time, hence Rosie continues mixing and accidentally uses salt instead of sugar.) A question for *The Very Naughty Puppy* asked "did Rosie pass her mum the book or the phone?" (She handed her mother the phone, so she could arrange for dog obedience classes.) For each child, the correct answers alternated equally often between the first and second choice in the question and whether the answer to Question 1 was first or second was counterbalanced across children. If children answered, "[I] don't know" the experimenter moved on and that question was not included in the child's score (i.e., proportion correct was calculated as the number correct out of the number of questions answered, see Samuelson and Horst, 2007).

We first piloted 12 questions from each story with 12 additional monolingual, British 3-year-old children (5 girls, 7 boys). These children heard each story once and answered all 12 plot comprehension questions immediately after each story. From these questions we selected nine for use in the main study, excluding the easiest and most difficult questions but maintaining the same number of questions per story. There was no difference in difficulty between stories for the questions used in the main experiment, $X^2_{(16)} = 3.44$, $p = 0.99$ ($M_{\text{baking}} = 0.77$, $SD_{\text{baking}} = 0.14$; $M_{\text{puppy}} = 0.73$, $SD_{\text{puppy}} = 0.21$; $M_{\text{restaurant}} = 0.72$, $SD_{\text{restaurant}} = 0.27$).

Children in the same story conditions were asked nine questions about their story after they had heard it once. Children in the different stories conditions were asked three questions about each story after they had heard the story once (for a total of nine questions). Which questions were asked for a given story was pseudo-randomly determined for each child as questions always occurred in story-chronological order. Plot questions were administered after the story enjoyment ratings so that discussing the plot would not influence children's ratings.

Immediate word learning test

The first word learning test occurred immediately after the third story was read and the enjoyment and plot questions were completed. This test included four warm-up trials to ensure the child understood the task. The experimenter told the child that they were going to play "a pointing game" and asked the child to show his or her pointing finger. Then the experimenter opened the test booklet to a practice page and asked the child to indicate each of the pictures in a pseudo-random order (e.g., "can you point to the car?"). Thus, at the end of the warm-up trials the child had practiced pointing to an object in each quadrant (e.g., top left). The same practice page was used for all four trials but different

practice pages were used from one test to the next (e.g., +24 h to +7 days). Children were praised for correct choices (100% of trials). Practice page, trial order, and target quadrants were counterbalanced within and across participants.

Next, children's comprehension of the target novel words was tested using the test pages from the test booklet. A different test page was used on each trial. Children were asked to point to each target twice for a total of four test trials. Across trials, targets were presented twice individually and twice together. For example, the child was presented with one *sprock* trial where the *tannin* was also present among the competitors, and one *sprock* trial where the *tannin* was not present among the competitors. Trial order, pages used and quadrant were counterbalanced within and across participants. The word learning task was the same as that used in previous research (Horst et al., 2011; Williams et al., 2011).

Delay phase

Working with the staff at the individual nurseries helped ensure that the learning phase was timed to occur no more than 30–45 min before children's regular nap times. After the immediate test, children who habitually napped took their naps and children who did not habitually nap played without any constraints except that they not be read anymore stories until after their next test phase. Children who did not nap were yoked to children who did nap to ensure that there was no difference in the length of the delay phase between groups, see **Table 1**, $F_{(3,\ 44)} = 1.05$, $p = 0.38$. There was also no difference in nap length between the same story nap and different stories nap conditions, $t_{(24)} = 0.44$, $p = 0.67$.

Subsequent word learning tests (+2.5 h, +24 h, +7 days)

Children were re-tested on their novel name comprehension three more times. The second test occurred approximately 2.5 h after the immediate test, the next occurred approximately 24 h after the immediate test and the final test occurred 7 days after the immediate test (see **Figure 1**). For each test the same procedure as the immediate test was used.

Coding

The experimenter recorded children's responses during each test. A member of the nursery/preschool staff observed the final test for each child to also record responses for inter-coder reliabilities (for a similar method see Horst et al., 2011). Staff members were naïve to the experimental hypotheses and design of the study. Staff members recorded children's responses out of the experimenter's view. Inter-coder reliability was 100%.

Table 1 | Delays between the immediate test and post consolidation test, including nap length.

	Same story		Different stories	
	Nap	No nap	Nap	No nap
Initial delay	143.33 min (21.60 min) 105–170 min	139.00 min (21.15 min) 110–175 min	150.00 min (18.00 min) 120–165 min	143.00 min (17.00 min) 110–170 min
Nap length	62.01 min (8.65 min) 50–75 min		64.12 min (13.90 min) 45–90 min	

Standard deviations presented in parentheses.

RESULTS

WORD COMPREHENSION

Here we provide a brief overview of the key findings before delving into the analyses. Results are depicted in **Figure 2**. As can be clearly seen, children who heard the same story repeated (thin blue lines) learned more words than children who heard different stories (thick red lines), thus replicating previous research. Further, children who napped (solid lines) performed significantly better than children who did not nap (dashed lines). Critically, children who heard different stories but then napped (solid red line), recovered after sleeping and continued to perform just as well as children who had heard the same story repeatedly and did not nap (dotted blue line). In contrast, children who heard different stories and did not nap (dotted red line) never recovered and never performed as well as their peers on the retention tests.

We first present analyses comparing children's word learning against chance and then between conditions. Children's word learning was assessed via 4-alternative forced-choice trials. Overall, children's novel name recall and retention accuracy was significantly better than expected by chance (0.25) for each condition at each test, all ps < 0.01 (all of our reported t-tests are two-tailed), see **Figure 2**. However, some of the test alternatives were never-before-seen novel objects (see e.g., Werchan and Gómez, 2014), which may have made the test easier than desired (Axelsson and Horst, 2013b). Recall, half of the trials children received included three novel distractors and half of the trials included the other target as a competitor along with two novel distractors. Presenting items as both targets and non-targets creates a stringent test of word learning (Schafer and Plunkett, 1998; Axelsson and Horst, 2013b). To gain more insight into how well

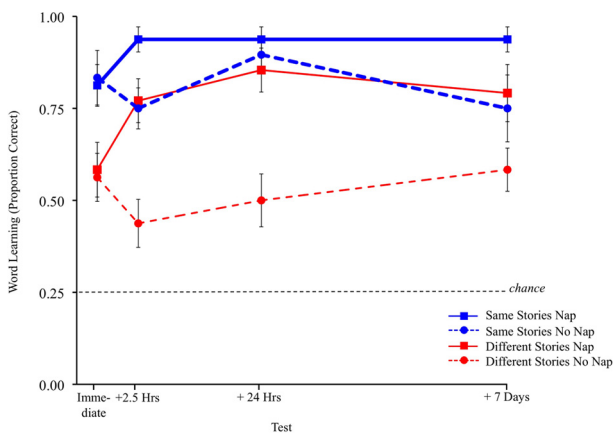

FIGURE 2 | Children's word learning on each test for each of the four conditions. Chance is 0.25. Error bars indicate one standard error of the mean.

children really learned the target words, we also compared only the trials in which the other target appeared as a distractor to a very conservative level of chance (0.50), see **Table 2**. When measured in this stringent way, children in the different stories no nap condition failed to demonstrate word learning at any point during the study (all means < 0.50). Children in the different stories nap condition did demonstrate word learning, but only after they had slept. Children in the same story conditions, generally demonstrated significant word learning, as would be expected from previous research (e.g., Horst et al., 2011), with the exceptions that the same story nap condition performed only marginally above chance before their naps ($p = 0.10$) and the same story no nap condition was not performing significantly above chance before overnight sleep ($p = 0.34$) or after 7 days ($p = 0.27$). Note, if chance on these trials is considered 0.25, both same story conditions consistently performed significantly above chance even on these challenging trials (all ps < 0.05).

Effects of repeated reading and sleep consolidation

Our main interest was the interaction between sleep and story exposure across time. In the following analyses we included data from all of the test trials because including all of the data provides the fullest picture of children's performance (Axelsson and Horst, 2013b), we did run these analyses on only the data from trials where both targets were present and found similar differences between conditions as in the data reported.

To test for differences between sleep and story conditions across time, children's proportions of correct choices were entered into a mixed-design ANOVA with Story Repetition (Same, Different) and Sleep (Nap, No Nap) as between-subjects factors and Test (Immediate, +2.5 h, +24 h, +7 days) as a repeated-measure. The ANOVA yielded a Story Repetition by Sleep by Test Interaction, $F_{(3,\ 132)} = 3.24$, $p = 0.02$, $\eta_p^2 = 0.07$ (see **Figure 2**). Thus, story repetition, together with sleep, influences children's word learning across time. The ANOVA also found a Sleep by Test Interaction, $F_{(3,\ 132)} = 9.35$, $p < 0.0001$, $\eta_p^2 = 0.18$. Sleep continued to influence children's word learning over the course of the study.

Children who heard the same story learned significantly more words than children who heard different stories, $F_{(1,\ 44)} = 19.45$, $p < 0.001$, $\eta_p^2 = 0.31$, see **Figure 2**. Further, children who napped learned significantly more words than children who did not nap, $F_{(1,\ 44)} = 10.68$, $p = 0.002$, $\eta_p^2 = 0.20$. Thus, both stories and sleeping shortly after hearing the stories had a profound effect on children's word learning. Finally, the ANOVA yielded a main effect of Test, $F_{(3,\ 132)} = 5.61$, $p = 0.001$, $\eta_p^2 = 0.11$. Children performed significantly better after 24 h than immediately after they heard the stories ($p < 0.001$) and than 2.5 h after they heard the stories ($p < 0.01$). Children also performed better 7 days later than immediately after they heard the stories ($p = 0.01$). No other significant effects were found.

Table 2 | Children's responses on word learning trials with the other target as a distractor.

	Same story		Different stories	
	Nap	No nap	Nap	No nap
Immediate test	0.67†	0.79*	0.38	0.38
	(0.33)	(0.33)	(0.43)	(0.38)
+2.5 h	0.92***	0.58††	0.71*	0.25*
	(0.19)	(0.29)	(0.26)	(0.34)
+24 h	0.92***	0.87**	0.79**	0.25*
	(0.19)	(0.23)	(0.26)	(0.34)
+7 days	0.92***	0.625††	0.75*	0.38
	(0.19)	(0.38)	(0.34)	(0.31)

*Standard deviations presented in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001 against chance (0.50), note some scores for the different stories no nap group are significantly below chance; $^{\dagger}p < 0.05$, $^{\dagger\dagger}p \leq 0.01$ against chance (0.25).*

Tests of simple effects

To better understand how sleep consolidation influences children's word learning via storybooks, we also conducted tests of simple effects. We ran separate ANOVAs for children in the same story conditions and different stories conditions. For children in the same story conditions, proportion of correct choices were entered into a mixed-design ANOVA with Sleep (Nap, No Nap) as a between-subjects factor and Test (Immediate, +2.5 h, +24 h, +7 days) as a repeated-measure. The ANOVA yielded a significant Sleep by Test Interaction, $F_{(3,\ 66)} = 4.51$, $p = 0.006$, $\eta_p^2 = 0.17$. The ANOVA also yielded a main effect of Test, $F_{(1,\ 22)} = 4.51$, $p = 0.05$, $\eta_p^2 = 0.11$. Follow-up tests confirmed children performed significantly better after 24 h than immediately after they heard the stories ($p < 0.01$), and than 2.5 h after they heard the stories ($p < 0.05$) and also than 7 days after they heard the stories ($p < 0.05$, see the thin blue lines in **Figure 2**). No main effect of Sleep was found; however, given that children have done well in previous studies in which they have heard the same stories repeatedly without napping (e.g., Horst et al., 2011), this is not unexpected.

We conducted an identical ANOVA for children in the different stories conditions. The ANOVA yielded a significant Sleep by Test Interaction, $F_{(3,\ 66)} = 7.75$, $p < 0.001$, $\eta_p^2 = 0.29$. The ANOVA also found a main effect of Sleep, $F_{(1,\ 22)} = 8.84$, $p < 0.007$, $\eta_p^2 = 0.55$, indicating that children who napped learned significantly more words than children who did not nap. Finally, the ANOVA found a main effect of Test, $F_{(3,\ 66)} = 4.11$, $p = 0.009$, $\eta_p^2 = 0.16$. Follow-up tests confirmed children performed significantly better 24 h later than immediately after they heard the stories ($p < 0.01$). Children also performed significantly better 7 days later than both immediately after they heard the stories ($p < 0.01$) and than 2.5 h after they heard the stories ($p = 0.03$, see the thick red lines in **Figure 2**).

STORY ENJOYMENT RATINGS

Overall, children liked the stories. Only three children answered that they did not like a particular story (one child in the same story no nap condition did not like *Nosy Rosie at the Restaurant;* one child in each of the different stories conditions did not like *Rosie's Bad Baking Day*). A Three-Way Story Repetition ×

Storybook × Rating contingency test, found no interactions between conditions or stories, all *p*s > 0.32.

All children were asked "How much did you enjoy reading all three stories today?" The majority of children in the same story conditions (83%) answered they liked reading "a lot," compared to only a third of children in the different stories conditions (33%), confirming that children do enjoy hearing the same stories read repeatedly, see **Table 3**. This finding is supported by both a Fisher's Exact Test, $p < 0.001$, and an unpaired *t*-test on answers transformed into a 3-point scale as "liked a lot" (3), "liked a little" (2), and "didn't like" (1), $t_{(46)} = 3.85$, $p < 0.001$, $d = 1.34$. Importantly, there was no difference in enjoyment ratings between children who napped and did not nap in the same story conditions, $t_{(22)} = 0.39$, $p = 0.70$, and different stories conditions, $t_{(22)} = -1.28$, $p = 0.21$, suggesting that the word learning differences observed between the two different stories conditions were due to the effect of sleep consolidation and not due to *a priori* differences story enjoyment [in fact, the children who did not nap enjoyed the stories slightly more ($M = 2.25$, $SD = 0.86$) than the children who did nap ($M = 1.83$, $SD = 0.72$)].

PLOT COMPREHENSION

Plot comprehension questions were included as a check to ensure children were attending to the stories during the shared storybook reading episode. Children in the different stories conditions answered three plot questions after each story. Overall, children in the different stories conditions answered the plot comprehension questions at levels significant better than expected by chance [50%, $M = 0.59$, $SD = 0.11$, $t_{(22)} = 3.14$, $p = 0.005$, $d = 1.34$]. Data from two girls (one in each different stories condition) were excluded from these analyses because they scored more than 2.5 standard deviations below (no nap) and above (nap) the means for their conditions. Both children performed similarly to the other children in the conditions on the other tests. There was no effect of story order [$F_{(2,\ 42)} = 1.41$, $p = 0.25$] or storybook [$F_{(2,\ 40)} = 0.55$, $p = 0.58$] on plot comprehension scores. Plot comprehension questions were administered before the initial delay phase and there was no difference in performance between children who did and did not nap, $t_{(21)} = 0.83$, $p = 0.42$. Importantly, this again suggests that the word learning differences observed between the two different stories conditions were due to the effect of sleep consolidation and not due to *a priori* differences in story understanding.

Table 3 | Children's responses to "How much did you enjoy reading all three stories today?"

	Same story	Different stories
"Liked a lot"	20***	8
"Liked a little"	3	9
"Did not like"	1	7
Total	24	24

****p < 0.001, exact binomial test based on p = 0.33 for 20 or more such responses out of 24.*

Children in the same story conditions answered nine questions about their story after the first reading. Children answered the questions at levels significantly better than expected by chance [50%, $M = 0.71$, $SD = 0.18$, $t_{(23)} = 7.02$, $p < 0.001$, $d = 1.88$], and there was no difference in performance between children who did and did not nap, $t_{(22)} = 0.19$, $p = 0.85$. Data from one child (same story no nap condition) were missing and not included in these analyses (this child performed similarly to the other children in her condition on the other tests). There was no difference in plot comprehension as a function of which storybook children heard [$F_{(2,\ 21)} = 0.65$, $p = 0.53$]. Note we did not directly compare plot question comprehension performance between story repetition conditions because it was not clear how the methodological differences might influence overall accuracy (e.g., how answering nine questions about the same story might provide scaffolding or how anticipating there will be questions after each new story might have led children to listen more intently).

PREDICTIVE EFFECTS OF STORY REPETITION AND SLEEP

Finally, we conducted a series of multiple regression analyses to determine if Story Repetition (Same, Different), Sleep (Nap, No Nap), Story Enjoyment and/or Plot Comprehension predict children's word learning performance on each retention test. For each regression analysis all predictors were entered simultaneously.

Table 4 depicts the models predicting performance on the first retention test (2.5 h after story exposure). Story Repetition is a significant predictor of word retention [$t_{(47)} = 3.68$, $p < 0.001$, $d = 1.13$] accounting for approximately 23% of the variation in word learning scores. Controlling for Story Repetition, Sleep (napping after story exposure) is also a significant predictor of word retention [$t_{(47)} = 4.99$, $p < 0.001$]. Together, Story Repetition and Sleep account for approximately 50% of the variation in word learning scores [$F_{(2,\ 47)} = 22.136$, $p < 0.001$, $\eta_p^2 = 0.33$]. Neither Story Enjoyment ($p = 0.63$) nor Plot Comprehension ($p = 0.65$) were significant predictors of word retention 2.5 h after story exposure.

Table 5 depicts the models predicting performance on the second retention test (24 h after initial story exposure). Again, Story Repetition is a significant predictor of word retention [$t_{(47)} = 3.74$, $p < 0.001$] accounting for approximately 23% of the variation in word learning scores. Controlling for Story Repetition, Sleep is also a significant predictor of word retention [$t_{(47)} =$

Table 4 | A series of regression models predicting children's word retention 2.5 h after story exposure based on story repetition, sleep, story enjoyment and plot comprehension.

	Word learning β (standardized)			
	Model 1	Model 2	Model 3	Model 4
Story repetition	0.48***	0.48***	0.45***	0.42**
Sleep		0.52***	0.52***	0.52***
Story enjoyment			0.06	0.01
Plot comprehension				0.06
R^2 (adjusted R^2)	0.23 (0.21)	0.50 (0.47)	0.50 (0.46)	0.50 (0.45)

****p < 0.001, **p < 0.01.*

3.43, $p < 0.001$]. Together, Story Repetition and Sleep account for approximately 39% of the variation in word learning scores the next day [$F_{(2, 47)} = 14.50$, $p < 0.001$, $\eta_p^2 = 0.28$]. Again, neither Story Enjoyment ($p = 0.62$) nor Plot Comprehension ($p = 0.43$) were significant predictors of word retention 24 h after story exposure.

Finally, **Table 6** depicts the models predicting performance 7 days later. Story Repetition remains is a significant predictor of word retention [$t_{(47)} = 2.21$, $p < 0.05$], but accounts for much less variation 7 days later than at the earlier time points (approximately 10% of the variation). Again, controlling for Story Repetition, Sleep is also a significant predictor of word retention [$t_{(47)} = 3.04$, $p < 0.01$]. In fact, napping after story exposure is a stronger predictor than Story Repetition. That is, over the long-term, sleep is more beneficial than story repetition for word learning. Together, Story Repetition and Sleep account for approximately 25% of the variation in word learning scores 7 days later [$F_{(2, 47)} = 7.50$, $p < 0.01$, $\eta_p^2 = 0.20$]. Finally, neither Story Enjoyment ($p = 0.58$) nor Plot Comprehension ($p = 0.39$) were significant predictors of word retention 7 days after story exposure.

Taken together, these data clearly demonstrate that both reading the same story repeatedly and sleeping shortly after story exposure significantly facilitated children's ability to learn words via shared storybook reading. These data also illustrate that sleep consolidation has a profound effect on children's word learning above and beyond story repetition.

Table 5 | A series of regression models predicting children's word retention 24 h after story exposure based on story repetition, sleep, story enjoyment and plot comprehension.

	Word Learning β (standardized)			
	Model 1	**Model 2**	**Model 3**	**Model 4**
Story repetition	0.48***	0.48***	0.52***	0.47**
Sleep		0.40**	0.39**	0.41**
Story enjoyment			−0.07	−0.09
Plot comprehension				0.10
R^2 (adjusted R^2)	0.23 (0.22)	0.39 (0.37)	0.40 (0.35)	0.42 (0.36)

$^{***}p < 0.001$, $^{**}p < 0.01$.

Table 6 | A series of regression models predicting children's word retention 7 days after story exposure based on story repetition, sleep, story enjoyment and plot comprehension.

	Word Learning β (standardized)			
	Model 1	**Model 2**	**Model 3**	**Model 4**
Story repetition	0.31*	0.31*	0.35*	0.31†
Sleep		0.39**	0.38**	0.41**
Story enjoyment			−0.08	−0.14
Plot comprehension				0.12
R^2 (adjusted R^2)	0.10 (0.08)	0.25 (0.22)	0.26 (0.21)	0.30 (0.22)

$^{**}p < 0.01$, $^{*}p < 0.05$, $^{\dagger}p = 0.05$.

DISCUSSION

Young children enjoy reading storybooks, including reading the same stories repeatedly (Sulzby, 1985; Sénéchal, 1997). The current study replicated previous research demonstrating that repeated readings facilitates word learning via storybooks and extended this research to investigate how sleep consolidation also facilitates word learning in preschool children above and beyond story repetition. Children who either habitually napped or did not nap were either read the same story three times or were read three different stories. Children were tested immediately after the shared reading episode as well as 2.5 h later (after half of the children had napped), 24 h later, and 7 days later. As in previous studies, we found a clear benefit for reading the same story repeatedly (Horst et al., 2011; Williams et al., 2011). Importantly, we also found a clear benefit for sleeping shortly after the shared reading episode. Children who slept after reading the stories performed significantly better than their peers on the later tests.

Most importantly, children who read different stories but then slept performed as well as children who had read the same story repeatedly but had not slept. That is, sleep allowed these children to consolidate the information they had heard such that they could demonstrate later word learning. Learning words from different stories is more difficult than learning words from the same story (e.g., Horst et al., 2011; Williams et al., 2011) and sleep allowed these children to compensate for this more difficult learning situation. In stark contrast, children who heard different stories and did not sleep never caught up to their peers—even after their regular overnight (recovery) sleep. Finally, regression analyses revealed that sleep consolidation was a stronger predictor of long-term word retention than story repetition. Taken together, these data demonstrate clear effects for both repeated readings and sleep consolidation on young children's word learning.

Note, accuracy on the plot comprehension questions did not predict children's word learning at any point during the study. However, the questions we used were designed to provide a check that children were listening to the stories in case we found poor word learning performance. As such, some of these questions tested memory for arguably subtle aspects of the stories (e.g., did Rosie give her mother a phone or a book). Future research should further investigate how comprehension questions can be better designed and used to aid comprehension of both the stories and new words embedded in the stories.

RELATION TO STORYBOOK READING LITERATURE

Previous research has already established that young children learn more words from repeatedly reading the same stories than reading different stories (Horst et al., 2011; Williams et al., 2011; Wilkinson and Houston-Price, 2013) or fewer stories (Sénéchal, 1997; Biemiller and Boote, 2006; McLeod and McDade, 2011). However, independent of our sleep factor, we extend this research in at least two important ways. First, we included intermediate tests of word recall between the initial test (immediately after reading) and the final test (7 days later). A comparison of our two groups who did not nap demonstrates that the advantage for encountering new words from the same storybook is persistent and robust. That word learning performance improves over time is consistent with other word learning studies (Backhaus

et al., 2008; Dumay and Gaskell, 2012) and suggests word learning is an extended process (Carey, 1978; Dumay and Gaskell, 2012; McMurray et al., 2012).

Second, after all of the stories were read, we asked all children "how much did you enjoy reading all three stories today?" Over 80% of the children who heard the same story repeatedly answered they liked the shared reading time "a lot," compared to only 33% of the children who had spent the same amount of time reading, but heard different stories. This has important educational implications because reading for pleasure is related to vocabulary level in later childhood (Sullivan and Brown, 2013). Thus, parents and teachers may want to foster an enjoyment of reading by reading the same stories repeatedly. Indeed, even adults enjoy reading stories when they already know the ending (Leavitt and Christenfeld, 2011).

However, it may be that there are benefits for reading different stories that we have not yet uncovered. Although 3-year-old children often have favorite books—which they repeatedly request—5-year-old children prefer a range of books (Sénéchal, 1988; Sénéchal and LeFevre, 2001). Ultimately, children are likely to learn all they can from a given story and will want to read something new. Research on how children learn words from fast mapping by mutual exclusivity demonstrates that, as in shared storybook reading, children retain words better when the contexts in which they learn the words repeat across learning opportunities (Axelsson and Horst, 2013a; Horst, 2013). However, other research suggests that variability promotes generalization (Perry et al., 2010; Twomey and Horst, 2011; Twomey et al., 2013; Werchan and Gómez, 2014). Thus, one possibility is that repeatedly reading the same story promotes *retention* by supporting children's initial encoding and storage of new name-object associations, but reading different stories facilitates *generalization* by allowing children to extend somewhat familiar name-object associations to new members from the given object category or new situations.

A related possibility is that reading different stories teaches children something about the concepts from the story (in our case object categories) that is not measured with the current tests. For example, in the current study children who heard different stories may have developed a deeper understanding of when and how to use a *sprock,* but were unable to demonstrate this understanding because we did not test them on their memory for the objects' functions or uses (for a similar argument see Biemiller and Boote, 2006). Future research should extend this work and explore how different aspects of shared storybook reading may promote learning of different types of information, e.g., object functions in addition to object names. Such research could also include children's ability to transfer knowledge from pictures to real objects (Ganea et al., 2008, 2011).

RELATION TO SLEEP LITERATURE

Previous research demonstrates that sleep supports children's learning (e.g., Hupbach et al., 2009; Henderson et al., 2012; Kurdziel et al., 2013; Wilhelm et al., 2013). The current study adds to this exciting area of research by exploring the word learning benefits of napping in preschool children. Specifically, children who slept after a shared storybook reading episode performed significantly better than their peers on later word learning tests. We know from previous shared storybook reading studies that children's recall for words encountered via different stories is significantly worse than recall for words encountered from the same stories read repeatedly (Horst et al., 2011; Williams et al., 2011; Wilkinson and Houston-Price, 2013), suggesting children's memory traces for words from different stories are weaker. Previously, Diekelmann et al. (2009) have argued that sleep consolidation benefits are greater for weak memory traces than for strong memory traces—which is exactly what we found. Word learning scores were 19% higher when children slept after hearing the same story, but 33% higher when children slept after hearing different stories.

Previous sleep consolidation research has been criticized for design issues (Stickgold, 2013) and circadian effects (Gais et al., 2006), however, the current study does not suffer from these limitations. For example, Stickgold (2013) recently criticized previous research for failing to include a measure of declarative knowledge at the end of training. Specifically, he argues that without such a baseline measure, it is unclear whether sleep is leading to better memory consolidation or whether an equivalent period of wakefulness is leading to forgetting. In the current study, we included a baseline measure (immediate test). A comparison of children's performance on the immediate test and the next test (2.5 h later) indicates that children's performance is both improving after sleep *and* declining after an equivalent similar period of wakefulness.

In addition, several studies test participants in either an AM or PM group (e.g., Gais et al., 2006; Dumay and Gaskell, 2007; Backhaus et al., 2008; Henderson et al., 2012). Unfortunately, in these cases performance may be confounded with time of day. In the current study we tested children at an age where some children still habitually take an afternoon nap and others do not (Mednick, 2013). This allowed us to test all children at the same time of day on each test and avoid circadian confounds (see Lau et al., 2010 for a discussion of the advantages of nap designs). In addition, by re-testing children 1 day (and 1 week) later, we were able to demonstrate that the difference between groups was not due to sleep deprivation because the differences between groups persisted after overnight sleep (for a similar argument see Kurdziel et al., 2013). Finally, we are also able to compare the effect of sleep shortly after learning (nap conditions) to the effect of overnight sleep (no nap conditions). Indeed, our tests of simple effects revealed an important main effect of sleep shortly after learning for children in the different stories conditions. This comparison is possible because we tested children at the same times (see also Hupbach et al., 2009).

However, unlike other studies (e.g., Yoo et al., 2007; Lau et al., 2010) we did not randomly assign children to nap or wake conditions. A major problem for sleep research is that sleep deprivation causes fatigue (Gais et al., 2006), although overnight sleep can control for this (Hupbach et al., 2009; Kurdziel et al., 2013). In the current study, children in the no nap conditions were not deprived of sleep, they had simply given up their naps. Note during early childhood (specifically 3–5 years of age) children who no longer nap sleep for longer at night and therefore children who nap and do not nap sleep for the same amount of time

within each 24-h period (Ward et al., 2008; Lam et al., 2011). It is possible that children in the current study who were still habitually napping by 42 months of age had other traits that helped them to learn the words more easily than the children who had given up their afternoon naps. Interestingly, napping may be only beneficial for preschool children who are still habitually having an afternoon nap (Kurdziel et al., 2013). For example, Lam et al. (2011) found 3–5-year-old children who no longer napped performed *better* on an auditory attention span task and vocabulary measures than their same-aged peers who still napped. The authors argue that giving up naps may be a developmental milestone for brain maturation. Critically, in the current study the immediate word learning accuracy scores were no different for children who would go on to nap and not nap in either story condition. Thus, we can be confident that any differences were not present immediately after learning.

Sleep might not be everything. For example, learning across different contexts (as in the case of learning words from different stories) might not benefit from sleep. Recently, Werchan and Gómez (2014) explained that wakefulness aids in forgetting, which is critical for generalization—especially for young children who encode both relevant and irrelevant details. In their study, they taught 30-month-old toddlers names for multiple, distinct exemplars from three novel object categories, which were presented across different contexts (in this case different colored backgrounds). Then, toddlers either napped or remained awake. When tested immediately or 4 h later, only toddlers who had remained awake for several hours generalized the novel object names to novel, never-before-seen exemplars from the object categories. In this case wakefulness facilitated learning, but in the current study sleep facilitated learning—especially for children who heard different stories. Note, however, we only tested children on the original objects from the story (e.g., a yellow *sprock*). Children who heard different stories may have demonstrated better word learning if we had tested them on new exemplars (e.g., a blue *sprock*). Thus, one important difference between the current study and Werchan and Gómez (2014) is whether children were learning to retain or generalize the new object names. Computational modeling work suggests that learning situations that promote later retention may not facilitate generalization and vice versa (Twomey and Horst, 2011; Twomey et al., 2013). Future research is needed to explore the interplay between retention and generalization and how sleep and wakefulness may facilitate different kinds of learning.

IMPLICATIONS

Due to the constraints of modern society, young children are now sleeping less than ever before and consistently less than recommended guidelines (see Matricciani et al., 2012, for a review). Further, chronically short sleep is significantly related to poorer vocabulary scores (Touchette et al., 2007), childhood obesity (Hart and Jelalian, 2008) and externalizing behaviors, such as tantrums (Scharf et al., 2013).

Many preschool children take an afternoon nap, yet classroom naps are increasingly being curtailed and replaced due to curriculum demands (Kurdziel et al., 2013; Mednick, 2013). Given the growing body of evidence that sleep consolidation has a significant effect on children's learning (e.g., Gais et al., 2006; Gómez et al., 2006; Hupbach et al., 2009; Henderson et al., 2012; Kurdziel et al., 2013; Wilhelm et al., 2013), such policies may be doing our children a huge disservice. In fact, findings like those from the current study indicate we should be encouraging young children to nap and should take advantage of the period right before they nap for instruction in key academic areas such as word learning (Gais et al., 2006) and arithmetic (Lodge, 2013). Kurdziel et al., 2013 even suggest that classroom naps may be particularly beneficial for children with learning delays (for a similar argument see Henderson et al., 2012). In addition, evidence suggests that learning is enhanced during the period *after* sleep (Yoo et al., 2007), suggesting that classroom naps may facilitate learning in the afternoon as well.

CONCLUSIONS

Reading to young children is entertaining (Sénéchal and LeFevre, 2001), provides an opportunity for closeness and bonding (Audet et al., 2008) and helps teach vocabulary (Sénéchal, 1997), print knowledge (Lonigan et al., 2008), and promote later academic abilities (Whitehurst et al., 1988; Rimm-Kaufman and Pianta, 2000). The current study demonstrates that reading to young children before they sleep—as many families do with the routine of the bedtime story (see e.g., Burke et al., 2004)—provides additional benefits in terms of word learning. Without any special training, parents provide children with especially rich language during bedtime story reading, including the kinds of linguistic features that are especially helpful for language acquisition (e.g., repetition, Dunn et al., 1977). Bedtime story reading also does not make the bedtime routine any longer (Field and Hernandez-Reif, 2001). Storybook reading prior to sleep, then, is a relatively quick and easy activity that children both learn from and enjoy: a parent's dream come true.

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Do storybooks really break children's gender stereotypes?

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A book review on
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DO STORYBOOKS REALLY BREAK CHILDREN'S GENDER STEREOTYPES?

Gender stereotypes—the features and characteristics assigned to men and women in a particular society—are prevalent in children as young as the preschool years (Martin and Ruble, 2004). For example, preschoolers can categorize toys as appropriate for either girls (e.g., dish-set) or boys (e.g., toolset), and play with them according to gender expectations (Raag and Rackliff, 1998). Many factors have been linked to the display and development of gender stereotypes in children, including the role of storybooks in shaping children's gender stereotypes (Jennings, 1975; Ashton, 1983; Trepanier-Street et al., 1990; Green et al., 2004). Storybooks are believed to help children understand the roles of men and women in society by reinforcing children's ideas about gender roles (i.e., what is typically appropriate for men and women) or, alternatively, by *challenging* these stereotypical gender roles. But, do storybooks really break children's gender stereotypes? In addressing this question, we briefly review literature that suggests storybooks can challenge children's gender stereotypes, discuss questions left unanswered by the current literature, and set the path for future research by arguing that researchers need to examine mechanisms affecting children's interpretations of gendered information in storybooks.

STORYBOOKS CHALLENGE CHILDREN'S GENDER STEREOTYPES: THE EVIDENCE

READING GENDER-*ATYPICAL* STORYBOOKS INCREASES PLAY WITH GENDER-*ATYPICAL* TOYS

Children prefer to play with toys stereotypically associated with their own sex, even before the age of three (O'Brien and Huston, 1985). However, some studies suggest that gender-*atypical* storybooks (e.g., storybooks where characters display behaviors usually associated with the opposite sex) can lead to changes in children's play behavior, even in children with the most stereotypical play behavior (Ashton, 1983; Green et al., 2004). In one study, 2–5-year-olds who were read a storybook about a same-sex child engaged in play with a gender-*atypical* toy immediately showed increased play with gender-*atypical* toys (e.g., girl participant hears a story about a girl playing with a dump truck and immediately increases play with trucks; Ashton, 1983). More recently, the play behavior of eight preschoolers identified as those with the most stereotypical play behavior was observed across 4 months (Green et al., 2004). During this time, children were exposed to two storybooks in which characters displayed gender-*atypical* toy play. For some children these gender-*atypical* storybooks resulted in significant, stable changes in their play behavior, with children showing increased play with gender-*atypical* toys and decreased play with gender stereotypical toys. These studies suggest that exposure to gender-*atypical* characters and behaviors in storybooks may impact children's immediate and future play behavior.

READING GENDER-*ATYPICAL* STORYBOOKS CHALLENGES CHILDREN'S STEREOTYPES ABOUT GENDER-APPROPRIATE OCCUPATIONS AND ACTIVITIES

Young children have preconceived notions about what occupations are appropriate for males and females, and tend to select occupations stereotypically associated with their gender when asked about their future careers (Liben et al., 2001). For instance, when asked about their interest in 37 occupations, elementary school boys expressed more interest in culturally masculine jobs (e.g., professor, mechanic) than feminine jobs (e.g., gymnast, teacher), while the opposite was true for girls (Liben et al., 2001). However, children's exposure to storybooks with female protagonists in *atypical* gender roles (i.e., activities; occupations) is linked to an increase in the number of occupations children believe are appropriate for women (Scott and Feldman-Summers, 1979; Trepanier-Street and Romatowski, 1999; Karniol and Gal-Disegni, 2009). For example, 3rd- and 4th-grade children who read stories in which female protagonists were engaged in gender-*atypical* activities (e.g., story about a female explorer) were more likely to report that

girls could engage in the gender-*atypical* activities portrayed in the stories (Scott and Feldman-Summers, 1979). In other research, 4–6-year-olds, upon reading and participating in teacher-mediated activities related to gender-*atypical* stories where characters were involved in *atypical* gender activities, situations, and occupations, rated more stereotypical occupations and activities as appropriate for both males and females (Trepanier-Street and Romatowski, 1999). Similarly, recent work by Karniol and Gal-Disegni (2009) found that first graders assigned gender-fair basal readers (i.e., textbooks used to teach reading) for the school year judged more activities (e.g., playing in mud, baking a cake) as appropriate for both males and females than those children assigned gender-stereotyped basal readers. These studies suggest that exposure to gender-*atypical* storybooks and readers challenge children's stereotypes about gender-appropriate occupations and activities.

READING GENDER *ATYPICAL* STORYBOOKS ALTERS CHILDREN'S FUTURE GOALS AND ASPIRATIONS

Perhaps one of the most exciting findings in the storybook and gender stereotype literature is Nhundu's (2007) study of Zimbabwean girls enrolled in 4th through 7th grade. Girls exposed to biographical stories of women succeeding in non-traditional careers not only reported that there were no jobs appropriate only for men or only for women, but also reported altering their *own* future career plans from gender-*typical* to gender-*atypical*. In contrast, significantly fewer girls who had not been exposed to these gender-*atypical* biographical stories (control group) changed their career goals; girls in the control group who did alter their future career goals at the completion of the study typically reported the desire for a gender-*typical* career rather than a gender-*atypical* career. These results suggest that the reading of gender-*atypical* storybooks can alter young girls' future career goals and aspirations.

STORYBOOK AND GENDER STEREOTYPE LITERATURE: UNANSWERED QUESTIONS

Despite these compelling findings that storybooks challenge children's gender stereotypes, there are some unanswered questions in the literature that should be addressed before we can assert that storybooks break children's gender stereotypes. We discuss these questions briefly, hoping they will stimulate more research on this topic.

HOW ARE CHILDREN INTERPRETING/REMEMBERING GENDER-*STEREOTYPICAL* AND -*ATYPICAL* INFORMATION?

Results are mixed with respect to how children interpret/remember gender-*atypical* information. Some find that children tend to misremember/distort gender-*atypical* information to make it consistent with gender stereotypes (Arthur and White, 1996; Daly et al., 1998; Frawley, 2008). In a study of 1st and 4th graders, children heard audiotaped readings of two books and were asked to retell stories and answer questions related to gender roles in the story (Frawley, 2008). Children who distorted gender-related information received feedback about their responses, yet they continued to misremember/reinterpret gender-*atypical* information to make it consistent with gender stereotypes. Still, others suggest that children remember gender-*atypical* information *better* due to novelty effects (Jennings, 1975; Trepanier-Street and Kropp, 1987). In another study, 32 preschool-aged children were read two different stories in which the character of the same sex: (1) performed a gender stereotypical activity (e.g., girl wanted to be a ballerina); and (2) performed a gender-*atypical* activity (e.g., boy wanted to be a dancer). After hearing these two stories, children were asked to report which story they preferred and were tested on their recall of information from each story. While children preferred stories that were consistent with gender stereotypes, they tended to remember information from the gender-*atypical* stories better. Given these mixed results from the literature, we argue that additional research be conducted to identify those factors (e.g., child age, child sex, child's previously-held stereotypes, amount of exposure to storybooks, and storybook plot/characters) that moderate children's memory for gender-*stereotypical* and –*atypical* information from storybooks.

DO STORYBOOKS CHALLENGE GENDER STEREOTYPES IN ALL CHILDREN?

The child's sex (Daly et al., 1998) and previously held stereotypes (Green et al., 2004) affect how responsive the child is to gender-*atypical* information in storybooks. Some find that the play behavior of some children does not change after exposure to gender-*atypical* storybooks, particularly in those children who are rated as having robust gender stereotypes (Green et al., 2004). Others argue that sex of the child is a good predictor of whether exposure to gender-*atypical* information in storybooks will impact the child. In many studies, girls' but not boys' gender stereotypes and play behavior can be altered with exposure to gender-*atypical* storybooks (e.g., Daly et al., 1998; Green et al., 2004). While both boys and girls can recall storybook information well when the protagonist is of the same sex and behaves in gender stereotypical ways, girls tend to remember more information about the story than boys when the protagonist does not conform to gender stereotypes (Daly et al., 1998). Others find that boys show gender stereotypes at a younger age and are less flexible in modifying these stereotypes (Ashton, 1983). Additionally, although it has been suggested that young children (5–6-year-olds) have the most rigid gender stereotypes (Ruble et al., 1998; Trautner et al., 2005), there is little conclusive evidence for differences in responsiveness to gender-*atypical* information in storybooks based on child age. Thus, more research is needed to evaluate potential sex and age differences on children's ability to recall gender-*atypical* information from storybooks, as well as whether and how boys' gender stereotypes can be altered using storybooks.

HOW MUCH AND WHAT KIND OF EXPOSURE TO GENDER-*ATYPICAL* INFORMATION IN STORYBOOKS IS NEEDED TO PROMOTE LASTING CHANGE?

Studies evaluating the effectiveness of gender-*atypical* storybooks in changing children's gender stereotypes vary considerably in the kind and amount of exposure to these stories. Some studies have looked at children's behavior and stereotypes after just one exposure to a gender-*atypical* storybook

(Ashton, 1983). Others have examined the effects of exposure to six different gender-*atypical* storybooks, along with teacher-mediated activities related to those storybooks, across 2 months (Trepanier-Street and Romatowski, 1999). Nhundu (2007) examined participants after a year of exposure to storybooks. Most published works assess only *immediate* change after exposure and find mixed results [e.g., Flerx et al. (1976) found an initial reduction of stereotypical thinking in preschoolers was not evident at 1-week follow-up]; to our knowledge, no studies have evaluated whether exposure results in long-lasting and/or permanent change in children's gender stereotypical beliefs/behaviors.

HOW GENERALIZABLE IS THE GENDER-*ATYPICAL* INFORMATION IN STORYBOOKS?

It is unclear whether information from gender-*atypical* storybooks extends beyond the specific circumstance the story portrays (i.e., activities, toys, careers). Participants are more likely to report that girls can engage in gender-*atypical* activities and play with gender-*atypical* toys portrayed in a storybook (Scott and Feldman-Summers, 1979), but do these beliefs/behaviors extend beyond the particulars of the storybook? Although some suggest generalizability (Trepanier-Street and Romatowski, 1999), there is reason to believe that these beliefs/behaviors do not extend beyond specific storybook content. While Nhundu (2007) saw that over 73% of girl participants had changed their career goals from traditional to non-traditional careers after long-term exposure to gender-*atypical* storybooks, she also reported that participants still held *traditional* gender role beliefs, such as that there are tasks only for men or women within the home setting and that married women should not have jobs that keep them from their in-home responsibilities. These results suggest that while storybooks have the potential to change children's gender role beliefs/behaviors, rather than challenging children's gender stereotypes in general, these changes are limited to the specific beliefs/behaviors portrayed in the storybooks.

STORYBOOK AND GENDER STEREOTYPE RESEARCH: A CALL FOR FURTHER RESEARCH

Storybooks are one way children learn about the world, learn about gender stereotypes, and potentially break gender stereotypes. Children's storybooks can provide a representation of societal values during a time when children are developing their gender roles, and thus, represent an important avenue for research on children's developing gender stereotypes. Gender-*atypical* storybooks may be a relatively easy, inexpensive way to expose children to a more gender-equitable worldview at home or in the classroom and, may serve as a powerful tool to challenge gender stereotypes. Existing evidence begins to shed light on how storybooks break gender stereotypes with studies documenting that reading gender-*atypical* storybooks not only increases play with gender-*atypical* toys and challenges children's stereotypes about gender-appropriate roles, but also alters children's future career goals and aspirations. There are, however, many questions to which we do not have an answer, including those that we addressed in the previous section. To understand the true impact storybooks have on children's developing gender stereotypes, we must examine the potential mechanisms explaining children's changing preferences from *typical* to *atypical* gender roles, beliefs, activities, and toys. We have identified several factors ripe for investigation and a careful examination of these potential factors will finally allow us to answer the question, "do storybooks really break children's gender stereotypes?"

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Rethinking the portrayal of deaf characters in children's picture books

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Keywords: deaf, culture, portrayal, children's picture books, deaf gain

Children's literature provides the opportunity for children to see both representations of themselves and of others in print and in pictures. Not only can engaging with picture books develop key literacy and language skills and a love of reading, but reading (and/or being read) high quality books also has the potential to foster an appreciation and respect for oneself and others. However, sometimes the diversity that exists in the real world is not represented well—or at all—in books created for young children (Mendoza and Reese, 2001; Kama, 2004). In this article we will discuss the lack of, and critical need for, children's books that portray Deaf[1] characters from a cultural perspective. We will also provide examples, from a sampling of children's picture books, of messages about deafness and deaf characters in text and illustrations (e.g., Golos and Moses, 2011; Golos et al., 2012). Finally, we will highlight the implications for both hearing and d/Deaf children as well as parents and educators.

Typically, when people think about deafness, they think about a person with a disability, that is, someone who is unable to do something (i.e., hear). This represents a pathological perspective of deafness, which entails viewing deafness as a disability or as a condition that needs to be fixed with medical intervention (i.e., cochlear implants or hearing aids; e.g., Lane, 1992; Lane et al., 1996; Padden and Humphries, 2006). Deaf studies scholars suggest an alternative view of deafness from a cultural perspective, in which the deaf person is seen a member of a minority population, the Deaf community, rich with their own language (i.e., American Sign Language or ASL) and culture (i.e., Deaf culture) (e.g., Lane et al., 1996).

PERSPECTIVES OF DEAFNESS AND DEAF PEOPLE IN LITERATURE

Prior to 1990, when researchers examined portrayal of characters with disabilities in media, deafness, similar to other disabilities, was stereotyped as a person, "needing to be fixed," "isolated," "angry," "in danger," and/or "unable to function in daily life" (e.g., Carlisle, 1998). It has only been recently that some have begun to *compare* portrayals of deafness for pathological vs. cultural perspectives. Although there has been an increasing awareness of Deaf culture, evidence from empirical studies suggests that the pathological perspective prevails (Golos, 2010; Golos and Moses, 2011; Golos et al., 2012). For example, we content analyzed the text and illustrations of 20 children's picture books published after 1990 and that included a main character who was deaf (Golos and Moses, 2011; Golos et al., 2012). Results showed that the majority of messages related a pathological perspective of deafness (71% of messages in the text and 93% of the messages in the illustrations).

Because of the prevalence of messages reflecting the pathological model of deafness, young readers may be more likely to experience books about deaf characters attending public schools and being mainstreamed with hearing children, as well as struggles they may face in such settings. For example, more often they may learn about characters like Oliver who cannot hear and, as a result, is isolated until he receives his hearing aid (Riski and Klakow, 2001).

Although cultural portrayals exist in children's literature, characters like Oliver dominate the literature. We found that the most common pathologically-oriented messages included references to fixing the character's deafness and having a greater ability to function or an improved quality of life after receiving amplification (e.g., hearing aid or cochlear implant) (Golos and Moses, 2011; Golos et al., 2012).

Another recurring message involved the deaf child in danger. For example, in one picture book, there is concern that a deaf character might get hit by a car because the character could not hear (Roth, 2000). In another story, an elementary-aged deaf child gets upset and runs into an elevator, does not know how to use it and gets stuck. Other characters are concerned because the boy cannot hear their verbal instructions (Watkins, 1993). Similar to the disability literature, these, and other similar messages found in the sample, perpetuate a stereotype of a deaf child as needing to be fixed or needing help to function in everyday situations (Carlisle, 1998; Golos and Moses, 2011; Golos et al., 2012).

Although the sample was small, there were very few cultural messages found in the text and illustrations of the 20 picture books analyzed. One of the few examples comes from the *Moses* series, in which the deaf character, Moses, attends a school for the deaf and everyone signs (including his family). When his mother asks Moses how his first day of school was he

[1] For the purpose of this paper, we define "d" deaf as someone with a hearing loss and "D" Deaf as someone who identifies themselves with the Deaf community.

responds, "I have 10 classmates. . . and all ten are my friends" (Millman, 2000, p. 27). Additional examples included aspects of the Deaf community (e.g., attending a Deaf theater production), or Deaf characters using flashing lights, and other *cultural* technologies used in everyday situations (i.e., without *medical* intervention) (e.g., Millman, 2000; Tildes, 2006).

However, it should be noted that books conveying more of a pathological perspective also contained some positive messages. For example, some books included messages related to positive relationships between the deaf child and his/her parent(s). In *Moonbird* (Dunbar, 2007), the parents learn the importance of communication and valuing their deaf child for who he is, and in *Dad and Me in the Morning* (Larkin, 1994), a hearing father and his deaf child bond while watching the sunrise. Moments such as these represent the critical connection between family members and their deaf child.

IMPLICATIONS REGARDING PERSPECTIVES ON DEAFNESS AND DEAF PEOPLE IN PICTURE BOOKS

One reason the pathological perspective dominates may be due to an increase in medical technology, such as cochlear implants. As a result, deaf children are increasingly mainstreamed into general education settings or placed in self-contained classrooms. However, in these settings, a deaf child often has limited interactions with other deaf children and/or Deaf adults, may not be taught or encouraged to use ASL and the classrooms often lack staff and/or resources to teach about Deaf culture.

Recent evidence suggests that deaf children, regardless of use of amplification, benefit from exposure to visual language such as ASL (e.g., Mayberry, 2007, 2010) and exposure to culturally Deaf role models (e.g., Holcomb, 1997). Deaf community members and national organizations for the Deaf (http://www.nad.org/issues/education/k-12/position-statement-schools-deaf) support schools for the deaf that offer access to ASL and Deaf culture as the preferred setting for most deaf children. However, for the increasing number of children not attending these schools, there may be a greater need for positive Deaf role models and positive messages about ASL. Utilizing children's picture books is one way to do so. They also can offer the hearing population messages to promote understanding and respect for d/Deaf people. However, to do so, they must contain accurate information about the Deaf community and Deaf culture.

Ultimately, picture books could have considerable impact on children's perceptions of themselves and others. If hearing children read (or are read) picture books that present a pathological view, they may learn that deafness is a disability, that a deaf person struggles in daily life, and that medical "fixes" are necessary in order for a deaf person to be happy, able to function, and be accepted. For the Deaf child, such depictions may cultivate a sense of inadequacy and/or low sense of self regarding who they are and what they can do. She/he may also feel the need to be "fixed."

If, on the other hand, picture books portray a cultural perspective of Deaf people, then deaf and hearing children could learn that Deaf culture exists and thrives and learn more about the language, history and values that are distinct from the hearing population. Through exposure and discussion about picture book messages, the hearing population could even serve as advocates for preserving the Deaf child's language and culture. Deaf readers may see that, like the main character in the *Moses* series, they can go to a school where Deaf teachers use sign language (e.g., ASL) and can learn to enjoy the arts, athletics, and academics utilizing their strengths in a visual language (e.g., ASL) and in a visual environment. This may promote a feeling of pride and help develop a strong sense of self.

FUTURE DIRECTIONS

Too often, being different from the majority is depicted negatively. Deaf studies scholars have coined the term "Deaf Gain" as a way of looking at the Deaf community from a perspective of benefit rather than loss (Bauman and Murray, 2009). That is, viewing deaf individuals as providing a unique to contribution to his/her community and broader society. Most notable are the visual "ways of being" (Bahan, 2009), including communicating through a visual language (e.g., ASL) and designing visual environments (lots of light, seats arranged in a way that everyone can see one another, etc.).

To help promote the concept of "Deaf Gain" in children's picture books, we encourage parents and teachers to incorporate books with cultural messages into their classrooms, and discuss these cultural messages. Recent examples, in addition to the *Moses* series, include new eBooks from Deaf authors/illustrators such as the *Zoey Goes* series. According to their website, the goal of their eBooks is for deaf children to "see themselves" and for hearing children to "learn about a linguistic minority" (zoeygoes.com). Parents and teachers can capitalize on these messages by discussing with children (hearing or deaf) how deaf people benefit from and access visual ways of being, such as using a light to get their dogs attention instead of calling him. However, there remains a need for high quality literature that incorporates more of these types of messages.

When pathological messages *are* present, educators should take the time to discuss them. For example, after reading the book about the deaf boy who gets stuck in the elevator, adults might ask children if they think that situation is realistic. Or, they might present examples of how all children can use visual strategies (that deaf individuals use) to do things, such as cross the street. Finally, children can learn that all deaf children, regardless of their use of medical technology or background can have friends, have skills and talents to share with others, and can lead meaningful lives.

FUTURE RESEARCH

As an area for future research, we suggest that children's picture books be examined for their quality. After examining some of the storylines and themes of children's picture books with deaf characters, one might question whether these stories would have been published if the characters were not deaf. For instance, would a story be published about an elementary-aged hearing child who did not know how to use an elevator? Although an empirical examination is needed to examine the quality of current literature, teachers should review storylines and messages in books before choosing to incorporate them in their classrooms. The ultimate goal is to choose books that are

worthy of children's time and attention that help develop their early literacy skills, and that provide important and accurate information about diverse populations.

CONCLUSION

Children's picture books hold the promise to promote awareness and appreciation. Yet in order to do this, diverse populations should be depicted positively and accurately. Picture books can portray "Deaf Gain" through images, fictional stories, biographies and other genres that portray the unique qualities and advantages of visual ways of being rather than the loss of hearing. However, even when alternate messages are present these topics should still be discussed with children so they develop an awareness and appreciation in hearing readers as well as pride and connection to Deaf culture and the Deaf Community in d/Deaf readers.

Just as our own favorite picture book from childhood stays with us through the years, so may the other characters and messages portrayed in picture books that display diverse people and diverse ways of being. Picture books have the potential to influence our thoughts, perceptions and identity, and choosing and discussing picture books for young children provides daily opportunities to inspire and enlighten. Ideally, books chosen for children should foster these positive outcomes creating both an immediate and lasting positive impression of themselves and others.

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Do cavies talk? The effect of anthropomorphic picture books on children's knowledge about animals

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Many books for young children present animals in fantastical and unrealistic ways, such as wearing clothes, talking and engaging in human-like activities. This research examined whether anthropomorphism in children's books affects children's learning and conceptions of animals, by specifically assessing the impact of depictions (a bird wearing clothes and reading a book) and language (bird described as talking and as having human intentions). In Study 1, 3-, 4-, and 5-year-old children saw picture books featuring realistic drawings of a novel animal. Half of the children also heard factual, realistic language, while the other half heard anthropomorphized language. In Study 2, we replicated the first study using anthropomorphic illustrations of real animals. The results show that the language used to describe animals in books has an effect on children's tendency to attribute human-like traits to animals, and that anthropomorphic storybooks affect younger children's learning of novel facts about animals. These results indicate that anthropomorphized animals in books may not only lead to less learning but also influence children's conceptual knowledge of animals.

Keywords: picture books, preschoolers, learning, animals, anthropomorphism

INTRODUCTION

For most young children, picture-book interaction is an important part of daily life. A growing body of research examines children's learning and transfer of information encountered in picture books to the real world (Simcock and DeLoache, 2006, 2008; Simcock and Dooley, 2007; Ganea et al., 2008, 2009, 2011; Tare et al., 2010; Simcock et al., 2011; Walker et al., 2012b; Khu et al., 2014; Keates et al., in press). This research has established that some elements of picture books (e.g., pictorial realism, manipulative features) impact children's ability to learn and transfer information from books. For example, across several studies using different methods it was found that more iconic pictures lead to better learning and transfer from picture books in young children than less iconic pictures do (Simcock and DeLoache, 2006; Ganea et al., 2008, 2009; Tare et al., 2010). In other words, the higher the level of similarity between the picture and the referent, the easier it is for children to transfer information between the two. Manipulative books are books that contain elements that a child could physically interact with, such as flaps to lift, textures to feel, tabs to pull, and so on. These elements are thought to make books engaging to young children, yet the research so far suggests that manipulative books may not be advantageous for learning. Studies that compared children's learning of content from simple, traditional books vs. manipulative books have found negative effects of manipulative elements on children's learning (Tare et al., 2010; Chiong and DeLoache, 2012).

Another important feature of picture books that can potentially impact children's learning has to do with the nature of the relation between the depiction and the referent, that is whether the depictions in picture books portray real entities in a realistic or fantastical manner. Many picture books for infants and young children depict reality in a distorted way. Human consciousness, knowledge, abilities, purpose, and intentions are often attributed to animal characters (e.g., seals solve mysteries, cats build houses and mice drive cars) and even to inanimate objects (e.g., lamps have faces and dance the tango, trains strive against all odds to achieve impossible goals). Fantasy elements are often employed even in books designed to convey serious information about the real world, including books with a focus on scientific knowledge. One question is whether the use of anthropomorphic elements in books might be counterproductive for learning (Ganea et al., 2011). Would the use of anthropomorphism to describe animals in picture books affect children's conceptual knowledge of real animals? In other words, does seeing animals talk and engage in human-like activities in children's picture books affect children's understanding of the biological and psychological properties of real non-human animals?

Urban 4- and 5-year-old children tend to use an anthropocentric model when reasoning about the biological world (Carey, 1985; Springer and Keil, 1989; Waxman and Medin, 2007). When asked to explain the behavior of non-human animals, preschool children take the human as the prototype and transfer properties from humans to other animals broadly. However, if a novel property is introduced in relation to a non-human animal (e.g., a dog), urban 4- and 5-year-olds are less likely to project it to humans. Recent work on children's biological reasoning has shown that, compared to urban 5-year-old children, the anthropocentric perspective on the biological world is not as predominant in urban

3-year-old children (Herrmann et al., 2010) and in children in rural communities who have more direct contact with animals (Waxman and Medin, 2007).

What explains these cultural and developmental differences regarding children's anthropocentric view of non-human animals? One possibility is that children growing up in different cultural settings (e.g., rural vs. urban) have different opportunities for informal learning about animals. In urban settings, children's direct exposure to animals is often limited and the books and media for young children depict animals in an anthropomorphic way (Inagaki, 1990; Rosengren et al., 1991). Also, with increased exposure with age to media that anthropomorphizes animals, children's view of animals may become more human-centered. Presenting animals to children in ways that are similar to how humans act and behave is likely to be counter-productive for learning scientifically accurate information about the biological world and to influence children's view of the biological world (Ganea et al., 2011).

Recent research on children's learning and transfer of knowledge from picture books has shown that children are more likely to transfer information from picture books when the information is presented in a story context "close" to the real world than in a context that is more dissimilar to the real world (Walker et al., 2012a). If children learned about a cause-effect relation from a story that depicted a boy who participated in realistic activities (e.g., having a picnic) they were more likely to use that causal information to explain a real life event than when they were exposed to a story about a boy who had a more fantastical experience (e.g., talking to a tree). This study indicates that the "proximity" of the story context to the real world affects the extent to which children transfer content from the book to reality (Walker et al., 2012a). In other words, children are sensitive to whether the structure of the story world resembles the structure of the real world, and their learning is disrupted if content information is portrayed in a "far" fantastical context. Thus, in terms of transfer of content knowledge, the existing evidence indicates that children are less likely to transfer content information from fantastical books to the real world compared to realistic books (Richert et al., 2009; Richert and Smith, 2011; Walker et al., 2012a). Adding fantasy elements to books that are supposed to teach children novel facts about animals could make it less likely that children will learn and transfer those facts.

In addition, adding fantastical elements in picture books could lead children to adopt an anthropocentric view of the natural world (Marriott, 2002; Sackes et al., 2009; Ganea et al., 2011). Picture books are a significant source of information about the biological world for young children and yet the majority of books for young children present the natural world in highly distorted ways (Marriott, 2002). Animal characters exhibit human characteristics and their natural environments are distorted, thus raising the question of how these representations of animals in picture books affect children's understanding of the biological world. Books that anthropomorphize animals may lead children to take a scientifically inaccurate view of the natural world by attributing human-like characteristics to non-human animals. This effect may be a result of seeing depictions of animals like humans (wearing clothes and engaging in human-like activities) and/or hearing descriptions of animals that include references to intentional human-like states and activities. The current research attempts to disentangle the contributing role of these two factors on children's learning and reasoning about non-human animals. More specifically, we will (1) ask whether children's ability to learn new biological information about a novel animal is affected by the type of picture book they are exposed to, and (2) determine the relative contribution that anthropomorphic images and language play in children's attributions of traits to real animals.

STUDY 1

The goal of Study 1 was to examine the effect of anthropomorphic language, used to describe novel animals in picture books, on both children's learning of facts about the novel animals and on their willingness to anthropomorphize biological and psychological properties of animals. Children were exposed to books that had realistic images of novel animals, however the language used to describe them was either factual or anthropomorphic. Thus, children were assigned to one of two book conditions: *No Anthropomorphism* (realistic images and factual language) or *Anthropomorphic Language* (realistic images and anthropomorphic language).

METHODS

Participants

Seventy-five children were recruited in the Boston metropolitan area. The majority of children ($N = 62$) were recruited using public birth records. The remaining children ($N = 13$) were recruited at a local science museum. Five children were dropped because of lack of cooperation ($N = 2$), prior knowledge of the novel animals ($N = 1$), or because they showed a response bias ($N = 2$). To be included in the study children had to answer "No" to at least two out of eight questions that had a "No" answer. Participants were divided into groups of 3-year-olds ($N = 24$; $M = 40.6$ months; Range = 36.0–47.1 months), 4-year-olds ($N = 24$; $M = 53.0$ months; Range = 48.0–59.6 months), and 5-year-olds ($N = 22$; $M = 66.7$ months; Range = 60.1–71.9 months). Females made up 50% ($N = 12$) of the 3-year-old sample, 50% ($N = 12$) of the 4-year-old sample, and 59% ($N = 13$) of the 5-year-old sample. Most of the participants were white (72%), but the sample also included Asian (5%), Black (2%), Hispanic (3%), and Mixed Race (11%) participants. An additional 7% of families declined to disclose ethnicity information. The majority of participants came from middle class families.

Materials

Six picture books were specifically designed for this study, featuring three animals that are unfamiliar to most children: cavies, oxpeckers, and handfish. The animals were chosen based on pilot testing in which children were asked to identify a series of animals from photographs. The three animals used in the picture books were those that were identified correctly least often, with children in the pilot study most frequently indicating that they did not know the names for these animals.

For each animal, two books were created according to condition. Both of these books provided three facts about the animal. The facts were about where the animal lives, what the animal eats,

and one other interesting fact (e.g., "Oxpeckers sit on the backs of large animals, like rhinoceros."). In the *No Anthropomorphism* condition the book featured realistic images and factual language. In the *Anthropomorphic Language* condition, the book featured realistic images and anthropomorphic language (e.g., "Mother cavy tucks her babies into bed in a small cave…'Don't be afraid,' she says. 'I'll listen for noises with my big ears to keep us safe."'). Supplementary Materials contains samples of the stories used in the two conditions, and **Figure 1** shows sample illustrations used in the two books; the left column images are sample images from the books used in Study 1. In addition to the picture books, color photographs of each real animal were used during the test phase of the study.

Design and procedure

Children were tested either in the laboratory or at the science museum. In both settings, children sat at a table to read the picture books with Experimenter 1 (E1). Experimenter 2 (E2) sat at a small side table with a large pile of papers and photographs as well as several file folders. The picture books were kept on a small shelf in a semi-hidden area, away from the main table. Children were assigned to either the *No Anthropomophism* or the *Anthropomorphic Language* book condition. Each child read one book about each of the animals with the experimenter, for a total of three books in each condition.

Each child was first greeted by E1, and spent a few minutes playing and warming up. E1 then led the child to the table, saying that they would read some books together. When E1 and the child arrived at the table, E1 introduced E2, saying, "This is my friend. She's going to do some work while we read." E2 then confirmed E1's statement, saying, "Yes, I have to organize all of these papers and pictures! I'll just be working while you read." E1 and the child then read the first book twice, to ensure that the child attended to the story. After they finished the book, E1 said, "I have another book we can read. You stay here and I'll go find it."

FIGURE 1 | Examples of realistic (left) and anthropomorphic (right) illustrations used in Study 1 and Study 2, respectively.

After E1 left the table, E2 approached the child and said, "I heard you reading about the cavy (or oxpecker or handfish), and guess what? I found this picture of a *real* cavy. I don't know anything about cavies. Can you help me answer some questions about this *real* cavy?" E2 emphasized to the child that the animal in the picture was real and that she did not know anything about the animal.

E2 then proceeded to ask the child six yes/no questions about the animal. All test questions can be found in Supplementary Materials. The questions included two factual questions about information that had been presented in the books used in both conditions, and two anthropomorphic questions that had been presented as things the animals did in the *Anthropomorphic Language* condition (e.g., talk, have friends). Of the six anthropomorphic questions across the three books, two focused on physical behaviors, two asked about human emotions, and two concerned social understanding. Two factual control questions, which were not taught in the books, were also included, to ensure that children's answers to the factual questions were gained from the book, and that they were not simply using their own background knowledge about animals.

Answers to the questions were counter-balanced, so that the correct answer for three of the questions was "yes" and for three of the questions was "no." Each child was asked the questions in the same order. After the child had answered all of the questions, E2 said, "Thanks for your help! I'm going to go back to my work. I think E1 will be back soon." Once E2 had gone back to the side table, E1 returned with the second book, and the procedure was repeated for that book, and again for the third book. The order in which the books were read was counterbalanced across children.

Children's answers to each question were scored dichotomously online, so that they received a score of "1" for each correct answer and a score of "0" if they gave an incorrect answer. A second coder scored 54% percent of the participants ($N = 38$) from videotape. Inter-rater reliability between the two coders was high (kappa $= 0.90$), and all discrepancies were resolved through discussion between the coders.

RESULTS AND DISCUSSION

We first determined the proportion of correct answers (out of six) that children provided for both the factual and control questions, and the proportion of times children did *not* extend anthropomorphic characteristics to the animals in response to the anthropomorphic questions. Thus, for anthropomorphic questions, higher scores reflect lower levels of anthropomorphizing. The means and standard deviations are provided in **Table 1** for each age group. Boys and girls did not differ, on average, in their answers to any of the types of questions.

First, we asked whether the type of language used in the book (anthropomorphic vs. factual) affected children's learning of novel facts about the target animals. To answer this question we conducted a 3 (age) × 2 (condition) × 2 (question type) mixed-effects ANOVA, with age (3, 4, 5) and condition (*No Anthropomorphism, Anthropomorphic Language*) as between-subjects factors and question type (factual, control) as a

Table 1 | Mean proportion of correct responses for children in the No Anthropomorphism (NA) and Anthropomorphic Language (AL) conditions, Study 1.

Question type	3 year olds		4 year olds		5 year olds	
	NA	AL	NA	AL	NA	AL
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Factual	0.83 (0.17)	0.75 (0.23)	0.92 (0.14)	0.96 (0.07)	0.98 (0.06)	0.94 (0.13)
Control	0.62 (0.23)	0.55 (0.17)	0.58 (0.29)	0.51 (0.28)	0.42 (0.19)	0.55 (0.22)
Anthropo-morphic	0.41 (0.30)	0.32 (0.24)	0.56 (0.30)	0.40 (0.30)	0.63 (0.18)	0.40 (0.24)

within-subjects factor. This analysis revealed a significant effect of question type, $F_{(1,\ 64)} = 104.68$, $p < 0.01$, $\eta p^2 = 0.62$, indicating that children performed significantly better on the factual questions ($M = 0.90$) than on the control questions ($M = 0.54$), $p < 0.01$. There was also a significant interaction between question type and age, $F_{(2,\ 64)} = 5.00$, $p < 0.01$, $\eta p^2 = 0.14$. Simple effects analysis indicated a significant effect of age, $F_{(2,64)} = 8.84$, $p < 0.01$, and Tukey pairwise comparisons showed that both 4- and 5-year-olds performed significantly better than 3-year-olds on the factual questions ($p < 0.01$, for both), but that there were no differences between the age groups on the control questions. Thus, although the children may have entered the task with some previous general knowledge about animals, the significant difference between their performances on the factual vs. the control questions indicates that children, especially the 4- and 5-year-olds, learned new facts from both types of books.

Second, we asked whether the type of language used in the book had an influence on how likely children were to attribute human-like characteristics to real animals. For this analysis we considered children's attribution of anthropomorphic characteristics across the two conditions. A 2 × 3 ANOVA examining children's answers to the anthropomorphic questions in terms of condition (*No Anthropomorphism, Anthropomorphic Language*) and age (3, 4, 5), revealed a main effect of condition, $F_{(1,\ 64)} = 6.43$, $p < 0.05$, $\eta p^2 = 0.09$. This indicates that children in all age groups were more likely to attribute anthropomorphic characteristics to real non-human animals after hearing a story with anthropomorphic language than after hearing a story with realistic language. Although there were no significant differences across age groups, the difference in attribution of anthropomorphic characteristics between conditions was most pronounced in 5-year-olds (*Mdiff* = 0.23).

Third, we asked whether children's attribution of anthropomorphic traits to non-human animals varies with the type of characteristic: physical behaviors (e.g., "Do cavies talk?"), emotions (e.g., "Can handfish feel proud?"), and social understanding (e.g., "Do oxpeckers have friends?"). A 3 (age) × 2 (condition) × 3 (type of anthropomorphism) mixed-effects ANOVA with age (3, 4, 5) and condition (*No Anthropomorphism*, *Anthropomorphic Language*) as between-subjects factors and type of anthropomorphism (behavior, emotion, social understanding) as a within-subjects effect was carried out. Significant effects of condition, $F_{(1,\ 64)} = 6.36$, $p < 0.05$, $\eta p^2 = 0.09$, and type of anthropomorphism, $F_{(2,\ 128)} = 19.89$, $p < 0.01$, $\eta p^2 = 0.237$, were found, revealing that children were less likely to extend anthropomorphic characteristics to animals in the *No Anthropomorphism* condition ($M = 0.53$) than in the *Anthropomorphic Language* condition ($M = 0.37$). Further, overall, children were less likely to extend anthropomorphic physical behaviors to animals ($M = 0.63$) than they were to extend either human-like emotions ($M = 0.36$) or social understanding ($M = 0.37$). A significant interaction between type of anthropomorphism and condition, $F_{(2,\ 128)} = 3.58$, $p < 0.05$, $\eta p^2 = 0.07$ was also found. Simple effects analysis indicated that children were more likely to extend both anthropomorphic physical behaviors, $F_{(1,\ 64)} = 7.02$, $p < 0.01$, and emotions, $F_{(1,\ 64)} = 7.86$, $p < 0.01$, in the *Anthropomorphic Language* condition than they were in the *No Anthropomorphism* condition, but there was no difference in their endorsement of anthropomorphic social understanding. This reveals that, like adults, young children seem to have a less clear conception of differences between humans and other animals in regard to mental characteristics, as opposed to behaviors (Horowitz and Bekoff, 2007). However, exposure to anthropomorphized language may encourage them to attribute more human-like characteristics to other animals than exposure to factual language.

To summarize, the results of Study 1 indicate that preschoolers can learn simple facts about animals from books, whether the information is presented to them in a context that uses realistic or anthropomorphic language to describe the animals. This ability is more robust in 4- and 5-year-olds than in 3-year-olds. This finding is consistent with the results of Ganea et al. (2011) regarding the learning of simple biological information (e.g., color camouflage) from picture books that varied the type of language (realistic vs. intentional) used.

The results also show that the type of language used in books affects how likely children are to attribute anthropomorphic traits to real animals. Children were more likely to say that real animals feel human emotions or even talk after listening to stories that used anthropomorphic rather than realistic language. There are two ways to explain this effect: either that the anthropomorphic language increases children's tendency to attribute anthropomorphic traits to animals, or that hearing realistic language suppresses their natural inclination to attribute human-like traits to other non-human animals. This question is examined in greater detail in Study 2.

STUDY 2

The results of Study 1 showed that the language children hear in picture books has important implications for their attribution of anthropomorphic traits to animals in the real world, though

not necessarily for their learning of factual information. In Study 2, we aimed to: (1) examine the contributing role of images, alone or in combination with language, on children's learning and reasoning about novel animals, and (2) ascertain whether anthropomorphism in picture books increases children's willingness to endorse anthropomorphic traits in animals, or whether realistic books serve to decrease children's natural anthropomorphic tendencies.

To address the first goal, children were exposed to books that had unrealistic images of novel animals, and the language used to describe them was either factual or anthropomorphic. Thus, children were assigned to one of two book conditions: *Anthropomorphic Pictures* (anthropomorphic images and factual language) or *Full Anthropomorphism* (anthropomorphic images and anthropomorphic language). In this study, parents were also asked to complete a questionnaire that asked about the average amount of time they spent reading books with their children each week, and the types of books their children enjoyed reading.

To address the second goal, a control *No Book* condition was run in which 5-year-old children were shown the photographs of the target real animals and asked the test questions without prior exposure to a picture book. Children's performance in this condition would provide an estimated baseline for 5-year-olds' tendency to attribute anthropomorphic characteristics to non-human animals, and thus, could be compared to their performance in the other conditions in this study. If 5-year-olds were just as likely to extend anthropomorphic characteristics in this condition as they were in the *No Anthropomorphism* condition in Study 1, than the difference seen in the *Anthropomorphism* conditions may reflect an enhancing effect of anthropomorphic picture books on children's anthropocentric reasoning.

METHODS

Participants

Eighty-eight children were recruited from the Greater Toronto Area. Children were recruited from an existing database of families who provided their contact information at local family-oriented festivals and infancy and childhood fairs. Sixteen children were excluded from the final analysis due to inattentiveness during testing ($N = 2$), a "yes" response bias ($N = 13$), or because they fell outside of the age range at the time of testing ($N = 1$). Participants were divided into two groups: 3-year-olds ($N = 27$; $M = 43.8$; Range = 36.4–47.9 months) and 5-year-olds ($N = 45$; $M = 66.10$; Range = 60.8–71.7). Because Study 1 indicated no overall differences between 4-year-olds and 5-year-olds, Study 2 focused exclusively on 3- and 5-year-olds. Females made up approximately half of the 5-year-olds ($N = 13$), and 63% ($N = 17$) of the 3-year-olds. As in Study 1, the majority of the participants were white (60%). The sample also included Black (2%), Asian (4%), and Mixed Race (8%) participants. An additional 11% of participants identified themselves as "Other," and ethnicity information was not provided by 15% of the participants. The majority of participants came from middle class families.

Materials

Six picture books were created by the experimenters, featuring the same novel animals that were used in Study 1: oxpeckers, cavies, and handfish. In this set of books, we manipulated the illustrations by featuring anthropomorphized depictions of the animals in all six books (see **Figure 1**, sample images on the right side column). As in Study 1, a photograph of each real animal was used during the test phase. The type of language used to describe the animals varied as a function of condition, either anthropomorphic or factual.

Design and procedure

All children were tested in a laboratory setting. The procedure was the same as that used in Study 1, except that parents were also given the questionnaire on book reading behavior mentioned above. Twenty-seven children from each age group were randomly assigned to either an *Anthropomorphic Pictures* condition or a *Full Anthropomorphism* condition. An additional 18 5-year-olds were assigned to the control *No Book* condition. Only 5-year-olds were assigned to this condition because the type of picture book used seemed to have the greatest effect on these older preschoolers in Study 1. Similarly to Study 1, children's answers to all questions were scored dichotomously online. A second coder scored 61% of the participants ($N = 33$) from videotapes. Interrater agreement was high, kappa = 0.97, and disagreements were resolved through discussion between the coders.

RESULTS AND DISCUSSION

The analyses were the same as in Study 1. Although girls made up slightly more than half of the 5-year-old sample, there were no differences between boys and girls on any of the test questions. Means and standard deviations for each age group are provided in **Table 2**.

First, we analyzed children's performance on the factual vs. control questions as a function of book condition. A 2 (age) × 2 (condition) × 2 (question type) mixed-effects ANOVA, with age (3, 5) and condition (*Anthropomorphic Pictures*, *Full Anthropomorphism*) as between-subjects factors, and question type (factual, control) as a within-subjects factor, indicated a significant effect of question type, $F_{(1,\ 50)} = 61.99$, $p < 0.01$, $\eta p^2 = 0.55$, a significant effect of age, $F_{(1,\ 50)} = 4.29$, $p < 0.05$, $\eta p^2 = 0.08$, and a significant interaction between question type and condition, $F_{(1,\ 50)} = 4.20$, $p < 0.05$, $\eta p^2 = 0.08$. As in Study 1, overall, children performed significantly better on factual questions ($M = 0.87$) than on control questions ($M = 0.54$), and 5-year-olds ($M = 0.75$) performed significantly better than 3-year-olds ($M = 0.65$). Further, simple effects analysis indicated that children answered fewer factual questions correctly in the *Full Anthropomorphism* condition than in the *Anthropomorphic Pictures* condition, $F_{(1,\ 50)} = 4.99$, $p < 0.05$. There was no significant difference between conditions on children's performance on the control questions. These results reveal that, although children were able to learn factual information about the animals from the picture books, they were less likely to do so when the books contained both anthropomorphic pictures and language.

Second, to examine the effect of the type of book on children's attribution of anthropomorphic traits, a 2 × 2 ANOVA was used, examining children's answers to the anthropomorphic questions in terms of condition (*Anthropomorphic pictures*, *Full Anthropomorphism*) and age (3, 5). A main effect of condition

Table 2 | Mean proportion of correct responses for children in the Anthropomorphic Pictures (AP), Full Anthropomorphism (FA), and No Book control condition in Study 2.

Question type	3 year olds		5 year olds		
	AP	FA	AP	FA	Control
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Factual	0.90 (0.11)	0.75 (0.21)	0.93 (0.15)	0.89 (0.15)	0.68 (0.21)
Control	0.45 (0.30)	0.52 (0.27)	0.55 (0.32)	0.63 (0.23)	0.64 (0.24)
Anthropomorphic	0.54 (0.24)	0.38 (0.29)	0.56 (0.23)	0.29 (0.19)	0.50 (0.23)

was found, $F_{(1,\ 50)} = 10.26$, $p < 0.01$, $\eta p^2 = 0.17$, indicating that children's scores on the anthropomorphic questions were significantly higher in the *Anthropomorphic Pictures* condition than in the *Full Anthropomorphism* condition. Thus, children who were exposed to books containing both anthropomorphic images and language were more likely to extend anthropomorphic characteristics to real animals than were children exposed to books with anthropomorphic images and factual language.

Third, as in Study 1, we asked whether children's endorsement of anthropomorphic characteristics differed according to the type of characteristic about which they were asked. A $2 \times 2 \times 3$ ANOVA with age group (3, 5) and condition (*No Anthropomorphism*, *Anthropomorphic Language*) as between-subjects factors and type of anthropomorphism (behavior, emotion, social understanding) as a within-subjects effect revealed a significant effect of type of anthropomorphism $F_{(2,\ 100)} = 17.89$, $p < 0.01$, $\eta p^2 = 0.26$, and a significant effect of condition $F_{(1,\ 50)} = 10.23$, $p < 0.01$, $\eta p^2 = 0.17$. Overall, children were less likely to endorse anthropomorphic physical behaviors ($M = 0.65$) than they were to endorse anthropomorphic emotions ($M = 0.33$) or social understanding ($M = 0.35$). Children were also less likely to extend anthropomorphic traits to animals in the *Anthropomorphic Pictures* condition ($M = 0.55$) than they were in the *Full Anthropomorphism* condition ($M = 0.33$). Significant interactions between type of anthropomorphism and age, $F_{(2,\ 100)} = 5.72$, $p < 0.01$, $\eta p^2 = 0.10$, as well as condition, $F_{(2,\ 100)} = 4.84$, $p < 0.05$, $\eta p^2 = 0.09$ were also found. Simple effects analyses indicated that children were more likely to extend both anthropomorphic behaviors, $F_{(1,\ 50)} = 12.37$, $p < 0.01$, and emotions, $F_{(1,\ 50)} = 11.63$, $p < 0.01$ to real animals in the *Full Anthropomorphism* condition than in the *Anthropomorphic Pictures* condition. There was no difference in children's attribution of social understanding to animals between conditions, but there was a significant effect of age, $F_{(1,\ 50)} = 6.66$, $p < 0.05$. Tukey pairwise comparisons indicated that, in the *Anthropomorphic Pictures* condition, 5-year-olds were significantly less likely to endorse anthropomorphic behaviors than they were to endorse emotions or social understanding ($p < 0.01$, for both).

To summarize, the results of Study 2 indicate that anthropomorphic illustrations in and of themselves have little effect on the information children take away from picture books. Both 3-year-olds and 5-year-olds learned factual information from books with anthropomorphic pictures. However, when anthropomorphic language and pictures were combined (*Full Anthropomorphism*), children at both ages were less likely to learn the facts from the books and apply them to the real animal.

A similar effect is seen in the effect of anthropomorphic illustrations on children's conceptions of animals' traits. Children were more likely to say that real animals have human-like characteristics after listening to stories that used *both* anthropomorphic language and images, than after listening to stories that used anthropomorphic images and realistic language. A comparable result was seen in Study 1 when realistic illustrations were used. In that study, children were more likely to attribute anthropomorphic characteristics to non-human animals after hearing stories containing anthropomorphic language. Taken together, these results indicate that the language in children's picture books may be more important than illustrations in children's conceptions of animals as human-like, but that the combination of both anthropomorphic language and pictures may make learning of facts from picture books difficult even for older preschoolers.

How anthropomorphic books affect anthropomorphic reasoning

The analyses in Studies 1 and 2 examining the effect of book type on how likely children were to attribute anthropomorphic traits to animals could not specify whether the anthropomorphic books enhanced children's extension of anthropomorphic traits to real animals, or whether realistic books inhibited children's tendency to anthropomorphize more generally. To be able to answer this question we compared children's performance in the conditions so far to a baseline control condition in which children were not read a storybook. This control condition was administered only to 5-year-olds, because the level of anthropomorphism in 3-year-olds did not vary much as a function of condition. A One-Way ANOVA comparing 5-year-olds' attribution of anthropomorphic traits across all conditions was performed. There was a significant effect of condition, $F_{(4,\ 66)} = 4.52$, $p < 0.01$, $\eta p^2 = 0.13$, and Tukey pairwise comparisons indicated that this effect was driven by the difference between the *No Anthropomorphism* and *Full Anthropomorphism* conditions ($p < 0.01$). Children were more likely to attribute human-like characteristics to real animals when exposed to a book with both anthropomorphic language and pictures than when exposed to a book containing realistic language and illustrations (**Figure 2**). There was a trend approaching significance for children in the *No Book* control condition to attribute fewer anthropomorphic traits to animals than did the children in the *Full Anthropomorphism* condition ($p = 0.07$).

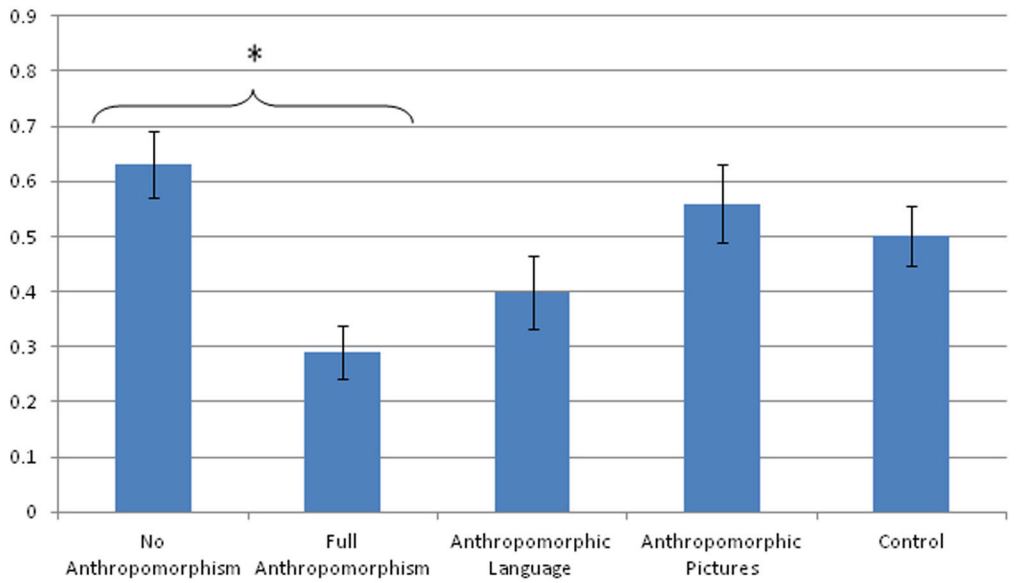

FIGURE 2 | Mean proportions of 5-year-olds' correct responses to the anthropomorphic questions across all conditions. $^*p < 0.05$.

Taken together, these findings indicate that anthropomorphic picture books, and especially books that combine anthropomorphic pictures and language, seem to encourage young children to endorse anthropomorphic traits for non-human animals. After reading such books, children were more likely to attribute human traits to real animals, and this endorsement of anthropomorphic characteristics was stronger than children's baseline anthropomorphism.

Possible predictors of children's learning from picture books

We also asked whether children's performance in this study was influenced by their general exposure to picture books or other demographic variables. Based on parents' responses to questionnaires, there were no differences between age groups, conditions, or genders in children's ethnicity or in SES variables, including parents' education and employment. Further, there were no mean differences between children in each condition or in each age group in terms of the amount of time they spent engaged with books each week, or their overall preferences for different types of books (fantasy vs. realistic books about animals; books that have photographs vs. drawings).

There were, however, some differences in book preferences between genders. For both 3- and 5-year-olds, parents reported that boys liked books about vehicles [$t_{(25)} = -5.13$, $p < 0.01$, $d = -2.05$, $t_{(25)} = -2.79$, $p < 0.05$, $d = -1.12$] and books about how things work [$t_{(25)} = -2.68$, $p < 0.05$, $d = -1.07$, $t_{(25)} = -2.54$, $p < 0.05$, $d = -1.02$] more than girls did. There were no other gender differences in children's preferences for different types of books. These preferences were unrelated to children's performance on the experimental task.

A multiple regression analysis indicated that neither children's SES, enjoyment of picture books, the amount of time spent reading each week, nor the specific types of books that children preferred to read were predictive of children's performance on the factual, control, or anthropomorphic questions.

GENERAL DISCUSSION

Many books for young children present animals in fantastical and unrealistic ways, as wearing clothes, talking and engaging in human-like activities. The research presented here suggests that books that anthropomorphize animals can affect children's conceptions of animals. Overall children in this research were less likely to attribute anthropomorphic characteristics to animals when exposed to books that presented animals in a realistic rather than anthropomorphic manner. Our results are consistent with recent findings indicating that 5-year-olds were less likely to transfer a new biological property from one non-human animal to others after reading a book that presented bears from an anthropomorphic perspective rather than from a biological perspective (Waxman et al., 2014). The current research expands on this finding by disentangling the contributing role of images and language in picture books on children's learning and reasoning about animals.

More specifically, after hearing stories that used anthropomorphic language to describe unfamiliar animals, preschoolers in the current research were more likely to extend both human physical behaviors and emotions when asked questions about those real animals. This effect was present even in a book condition where only the language was anthropomorphized (Study 1). Thus, even when seeing realistic images of the animals and their environment, if the language used to describe them was animistic, children were more likely to attribute anthropomorphic traits when asked questions about the real animals compared to children who heard realistic language. Although this tendency did not differ as a function of age, it seemed stronger in the

5-year-olds in this research. There is evidence that anthropomorphism may be acquired between 3 and 5 years of age in urban children (Herrmann et al., 2010) and thus it is possible that the younger children may not have yet developed the same level of sensitivity to typical cultural input (language in particular) about biological phenomena as the 5-year-olds.

A second important finding from this research is that children learned more facts about animals from books that used factual language and/or realistic illustrations to describe the animals. When children in Study 2 were exposed to books where anthropomorphic images and language were combined they were less likely to apply the facts to photographs of the real animals compared to a book that used only anthropomorphic images. This type of book, which combines both fantastical language and anthropomorphic illustrations of animals, is typical of commercially available books. Our results suggest that this combination may create a story context that is too dissimilar from reality for preschoolers to realize that information important for the real world is being conveyed. As children get older and have more experience with fantastical stories, they may acquire knowledge that information encountered in fantastical books can be relevant to the real world, but the current findings indicate that this is not yet the case for preschool-aged children. This effect is especially true when both the images and language used in the story were fantastical—children learned fewer facts about real animals in this condition.

This research adds to the growing body of literature on how picture-book features support or detract from young children's learning and holds important implications for a wide audience. These findings inform parents and teachers about how to select pictures books that will aid children's transfer of factual information from books to the real world. Together with related research cautioning on the use of fantasy features in educational books (Richert et al., 2009; Ganea et al., 2011; Walker et al., 2012a), this work suggests that if the goal of the picture book interaction is to teach children information about the world, it is best to use books that depict the world in a realistic rather than fantastical manner. More specifically, if we want children to learn new things about animals, we need to expose them to stories that present the animals and their environments in a biologically realistic manner, both in the way that they are depicted and the way they are described. Based on these results, teachers might also choose to supplement their picture book selection in the classroom with live display of animals to aid children's biological conceptions of real animals and their habitats.

Recent findings with adults show that there are individual differences in adults' tendency to anthropomorphize nature (Waytz et al., 2010). Developmental research examining children's anthropomorphism has also shown that the tendency to attribute a property to an animal once it was introduced for a human base is not as prevalent at 3 years of age as it is at 5 years of age (Herrmann et al., 2010) and it is most common in urban cultures (Ross et al., 2003; Waxman and Medin, 2007). Our research suggests that an important factor in the development of anthropomorphism in childhood may be exposure to media (e.g., picture books, television) that commonly portrays animals and other inanimate entities with human-like characteristics (see also Waxman et al., 2014). Such portrayals can lead children to think of entities in the natural world as imbued with intentions and human-like states.

As cultural artifacts, books can communicate a culture's epistemological orientation toward nature (Dehghani et al., 2013), and thus, they can provide opportunities to introduce children to science concepts early on. The tendency to reason about the biological world from an anthropocentric point of view can have negative consequences for children's causal biological understanding. For example, research with older children has shown they have more difficulty accurately interpreting evolutionary change when those concepts are presented using anthropomorphic language (Legare et al., 2013). In light of the current findings and the documented potential of books to introduce young children to concepts about natural phenomena early on (Ganea et al., 2011; Kelemen et al., 2014), future research should further investigate the ways in which picture books can influence children's reasoning about the natural world. In the current research we examined preschoolers' reasoning in relation to the specific animals presented in the books they were exposed to. The results show that children are more likely to endorse anthropocentric traits for specific animals after being exposed to books that anthropomorphize those animals than after being exposed to books that present the animals in a realistic manner. Future research should examine whether the type of books children read will also affect how likely children are to endorse anthropomorphic traits to other novel animals that they have not read about. It would also be important to know whether books have a similar impact on children growing in different communities. For example, we might predict that anthropomorphic books might have less impact on children who have more direct contact with animals and who are generally exposed to discourse about animals that is not human-centered.

To conclude, picture books are an important source of information about the world and in particular about things and events that children cannot experience directly. Despite their potential to broaden children's general knowledge about the world, only a very small percentage of the books teachers select for their classrooms are informational and non-fiction books, both in preschool (Yopp and Yopp, 2006; Pentimonti et al., 2011) and first grade (Duke, 2000). Most of the books in classrooms for young children fall along a continuum from purely fictional storybooks to hybrid books that include a mixture of fantasy and factual information in a narrative format. Although these types of books are important for other aspects of children's development, the research presented here points to the importance of carefully considering the type of books that we use with young children when teaching them new information about the world. Books that do not present animals and their environments accurately from a biological perspective may not only lead to less learning but also influence children to adopt a human-centered view of the natural world.

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SUPPLEMENTARY MATERIAL

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Humans (really) are animals: picture-book reading influences 5-year-old urban children's construal of the relation between humans and non-human animals

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What is the relation between humans and non-human animals? From a *biological* perspective, we view humans as one species among many, but in the fables and films we create for children, we often offer an *anthropocentric* perspective, imbuing non-human animals with human-like characteristics. What are the consequences of these distinctly different perspectives on children's reasoning about the natural world? Some have argued that children universally begin with an anthropocentric perspective and that acquiring a biological perspective requires a basic conceptual change (cf. Carey, 1985). But recent work reveals that this anthropocentric perspective, evidenced in urban 5-year-olds, is not evident in 3-year-olds (Herrmann et al., 2010). This indicates that the anthropocentric perspective is not an obligatory first step in children's reasoning about biological phenomena. In the current paper, we introduced a priming manipulation to assess whether 5-year-olds' reasoning about a novel biological property is influenced by the perspectives they encounter in children's books. Just before participating in a reasoning task, each child read a book about bears with an experimenter. What varied was whether bears were depicted from an anthropomorphic (Berenstain Bears) or biological perspective (Animal Encyclopedia). The priming had a dramatic effect. Children reading the Berenstain Bears showed the standard anthropocentric reasoning pattern, but those reading the Animal Encyclopedia adopted a biological pattern. This offers evidence that urban 5-year-olds can adopt either a biological or a human-centered stance, depending upon the context. Thus, children's books and other media are double-edged swords. Media may (inadvertently) support human-centered reasoning in young children, but may also be instrumental in redirecting children's attention to a biological model.

Keywords: cognitive development, biological reasoning, cultural priming, children's books, anthropocentrism

INTRODUCTION

Infants and young children greet the creatures of the natural world with special delight. For one of our daughters, it all started with her dog Roger – a stuffed animal who arrived in the newborn nursery only a few hours after she did and rarely left her side for more than a decade. Like most young children, she also delighted in images and animations of animals. Her first books included *Goodnight Moon* (whose main character is, after all, a little mouse). Years later, her favorite books included *Stellaluna* (a "switched at birth" story whose main character, a baby bat, finds herself living amongst a family of birds, all of whom talk – in English – about food preferences, emotions, and a sense of belonging). Perhaps not surprisingly, this little child who so loved animals announced that she was going to be a veterinarian when she grew up.

There is, of course, a huge gap between her storybook characters and the real, living and breathing animals that occupy the natural world. But is not this gap easily traversed? Do not the charming characters that young children encounter in their picture books support their natural fascination with animals and spark early learning about the biological world? These questions provide the underlying focus of this paper. Our goal is (a) to summarize evidence documenting how the relations between human and non-human animals are portrayed in children's books, (b) to summarize recent research documenting how young children from diverse cultures reason about the relation between human and non-human animals, and (c) to present new experimental evidence documenting how the books that we read to children influence the ways in which they then reason about animals.

CHILDREN'S PICTURE BOOKS

Picture books serve as sources of social engagement for children with adults in their close communities and as gateways for learning. By 15 months of age, infants successfully learn names ("vase," "aardvark") for novel objects that are introduced in picture books. More remarkably, infants spontaneously extend these names beyond pictorial representations, using them to name real three-dimensional objects when they encounter them in the world (Preissler and Carey, 2004; Ganea et al., 2008, 2011; Geraghty et al., 2011).

Although children's books primarily have figured in research on early literacy and educational readiness (Poulsen et al., 1979; Pappas, 1986; Fletcher and Reese, 2005; Mar and Oatley, 2008),

more recently this focus has been expanded to include investigations of children's learning about the natural world (Ganea et al., 2008, 2011; Legare et al., 2013). Preschool-aged children can learn biological information presented in children's books and use this information to reason about real, living animals (Ganea et al., 2008, 2011).

But children's books provide something more than explicit information. They are cultural products that both *reflect* the orientations of their creators and may also *affect* the orientations adopted by their viewers (Morling and Lamoreaux, 2008; see Cole and Engeström, 1993 for an overview). For example, Tsai et al. (2007) identified two key differences in popular children's books from the US and Taiwan. First, US storybooks were more likely than those from Taiwan to depict excited (versus calm) characters. Second, reading these books influenced the activity preferences and perceptions of happiness of children in both countries. Results like these indicate that children's books reveal cultural orientations that affect *what* people think (D'Andrade, 1981) and *how* they think (Nisbett and Masuda, 2003, 2007).

Recent work from our research group provides converging evidence for the role of culture and cultural artifacts in development. As part of a larger project aimed at identifying how young children from different cultural communities reason about the natural world (e.g., Wolff et al., 1999; Waxman et al., 2007; Atran and Medin, 2008; Anggoro et al., 2010; Bang et al., 2010; Herrmann et al., 2010; Waxman et al., 2013; Medin and Bang, 2014), we asked whether and how our own perspectives of the natural world are embedded within children's books. We examined popular children's books that were written and illustrated by members of two cultural communities: Native Americans or non-Native Americans (Bang et al., in press; Dehghani et al., 2013). We found large cultural differences in the Native and non-Native books' portrayals of the natural world and the place of humans within it. For example, illustrations from the Native-authored books provided a greater variety of perspectives and, most relevant to our present study, rarely if ever depicted animals wearing or surrounded by human artifacts, in sharp contrast to the heavily anthropomorphized non-Native books. Do these differences make a difference? That is, do children's books also *shape* children's reasoning about the natural world and their place within it?

DEVELOPMENTAL MATTERS

This brings us to the question of how young children conceptualize and reason about the relation between human and non-human animals. As adults, we view this relation flexibly, adopting several different vantage points. Most Western-educated adults readily adopt a biological perspective, construing humans as one among the many species of the animal kingdom. But we also adopt a different construal, in which humans are set *apart from* the other animal species. Consider admonitions like "Don't eat like an animal!" or the story of Genesis in which humans ". . .have dominion over the fish of the sea, and over the birds of the heavens, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth" (American Standard Version Bible, 1901) Even within the scientific community, humans are *apart from* non-human animals: Federal funding agencies require that research involving exclusively *human* participants be designated as research that does *not* include animals. Notice, however, that yet another perspective is pervasive, in which non-human animals are represented as surrogate humans. This strongly anthropocentric perspective is especially prevalent in the media designed for young children (cf., *Goodnight Moon, Stellaluna, Bambi*).

How do these different perspectives develop? Which are available early, before formal science instruction begins? One strong line of developmental work has suggested that when young children consider the natural world, they may be able to adopt only a single perspective, reasoning exclusively from an anthropocentric perspective and only later in childhood beginning to appreciate a biological perspective. But more recent work suggests that this picture might not be so clear.

EARLY ANTHROPOCENTRIC REASONING

The strongest evidence for an early anthropocentric stance came from young urban children's performance in an inductive reasoning task, pioneered by Carey (1985). In this task, participants were introduced to a novel biological property (e.g., "has an omentum"), told that this property is true of one biological kind (e.g., either a human or a dog), and then asked to decide which other entities might share this property. Carey documented a dramatic developmental progression, one that has been replicated robustly in several other urban communities. If the novel property was introduced as true of a human, 4-year olds projected the property broadly to other animals; but if the same property was attributed to a non-human animal (e.g., a dog), they did not generalize it broadly to other animals. In short, it was as if humans were the only proper base for generalization. Older children and adults projected the novel biological property broadly from one animal to another, whether it had been introduced as true of a human or non-human animal (e.g., a dog).

For decades, results like these were taken as evidence that young children begin reasoning about the biological world from an exclusively anthropocentric stance, comparing animals to a single prototype or standard (humans) and that they then undergo a conceptual change as they move from this human-centered model of *naïve psychology* (in which humans serve as the paragon) to the more mature, Western science-inspired model of *naïve biology* (in which humans are viewed as one biological kind among many; Carey, 1985, 1988, 1995).

This claim generated considerable interest and debate (Gelman and Wellman, 1991; Coley, 1995, 2007; Gutheil et al., 1998; Inagaki and Hatano, 2002; Heyman et al., 2003; Keil, 2007). Some have suggested that humans may be privileged in young children's reasoning because urban children (who constitute the vast majority of research participants) simply know more about humans than non-human animals (Keil, 1992, 2007; Hatano and Inagaki, 1999; Heyman et al., 2003). Recent evidence from young children raised in rural communities, whose direct experience with non-human animals is considerably richer than that of urban-raised children, provided support for this interpretation. Rural 5-year-olds do not privilege humans over non-human animals when reasoning about biological phenomena (e.g., Sousa et al., 2002; Ross et al., 2003; Waxman and Medin, 2007). This outcome is important, but it does not shed light on whether anthropocentrism is the initial state. After all, because rural children have rich engagement with

and exposure to the natural world, they may begin with an anthropocentric perspective but move beyond it sooner than their urban counterparts.

To address whether children really do universally begin reasoning from an anthropocentric perspective, we modified the now-classic induction task (Carey, 1985) to tap into the reasoning of children as young as 3 years of age (Herrmann et al., 2010). We reasoned that if the anthropocentric perspective is not an obligatory initial step but rather an acquired cultural model, then urban 3-year-olds might be *less* likely than their 5-year-old counterparts to privilege humans when reasoning about biological phenomena. The results provided clear support for this view: 3-year-old children showed no hint of anthropocentrism in their reasoning; they projected the novel biological property systematically from both human and non-human bases to other animals. Unlike 5-year-olds, 3-year-olds did not use humans as a privileged base for inductive reasoning about the biological world.

These developmental results also raised two important questions. First, if anthropocentrism is an acquired perspective, why is it acquired by 5-year-old children raised in some (cf. urban) but not all contexts? Second, what becomes of the biological perspective evidenced by 3-year-old children (Herrmann et al., 2010)? We suspect that this perspective is not discarded just 2 years later; instead, 5-year-old urban children may have access to both a biological perspective as well as an anthropocentric one (see also Gutheil et al., 1998). More specifically, we propose that in urban technologically saturated communities, where direct habitual contact with non-human animals is relatively limited (Rogoff et al., 2003), children encounter considerable support (intended or not) for an anthropocentric perspective and little in the way of direct experience to countervail it.

There is no doubt that images of non-human animals that children encounter in the books and media we design for them often take an anthropocentric cast (Marriott, 2002). But can representations like these actually influence their reasoning about the natural world?

EXPERIMENT

To address this question, we selected two popular children's books written and illustrated by European American authors with young children in mind. Both included bears as their focal character, but offered very different construals of bears. In one, *The Berenstain Bears' Bedtime Battle* (Berenstain and Berenstain, 2004), bears are depicted as drawings, in a decidedly anthropocentric fashion (wearing clothes, speaking in English, engaging in human activities like birthday parties). In the other, *First Animal Encyclopedia* (Arlon, 2004), bears are depicted in a more realistic fashion, as photographs within their natural habitats and engaged in species-typical behaviors (foraging, building dens, caring for their young). If reading the Berenstain Bears book taps into an underlying anthropocentric model, then 5-year-old urban children reading excerpts from *Berenstain Bears* should adopt an anthropocentric stance in a subsequent reasoning task [privileging the human over the non-human animal (here, a dog) as an inductive base]. If reading about bears living in the natural world taps into a different, more biologically based construal, then 5-year-old urban children reading excerpts from the *Animal Encyclopedia* condition should adopt a different, non-anthropocentric stance (in which both humans and dogs serve as a strong inductive base for reasoning about other animals). Notice that this is a modest manipulation, especially when considered in light of the powerful media and conversational support that children receive for an anthropocentric perspective. If this book-reading manipulation is effective in eliciting biological patterns of reasoning even in the face of children's saturation with anthopocentric images, this will suggest not only that children do indeed represent a biological perspective, but also can access it readily.

This design also allowed us to address another key question concerning the flexibility of children's representations of the relation between human and non-human animals. If the anthropocentrism evinced by urban 5-year-olds is the only construal available to them when reasoning about the biological world, then reading *Animal Encyclopedia* should have little effect. But if they are also able to appreciate a non-anthropocentric model, and if *Animal Encyclopedia* effectively primes this model, they should be more likely to reveal a biological (rather than anthropocentric) pattern of reasoning after reading *Animal Encyclopedia*.

METHODS

PARTICIPANTS

Sixty-two typically developing 5-year-olds (34 female; 28 male), ranging from 60.1 to 71.5 months ($M = 65.8$), were recruited from the greater Chicago area and participated with their guardians' consent. Children were drawn primarily from middle-class, majority-culture families. Two additional children were excluded from analysis for failure to meet inclusion criteria.

MATERIALS

Two children's books, *The Berenstain Bears' Bedtime Battle* (Berenstain and Berenstain, 2004) and *First Animal Encyclopedia* (Arlon, 2004) were used during the priming phase. Both were written and illustrated with young audiences in mind. In *The Berenstain Bears*, the illustrations were drawings; in *First Animal Encyclopedia*, the illustrations were photographic images. In addition, materials included (a) simple outline drawings of a human and a dog (used in the teaching phase), (b) six different finger-puppets (presented as pairs in the training and test phases), and (c) a series of 6" × 4" laminated, color photographs of humans, animals, plants, and artifacts, presented against natural backgrounds. Two photographs served as bases (human; dog). The remaining thirteen photographs served as targets. See **Figure 1**.

PROCEDURE

Children sat across from the experimenter in a quiet testing room. Children were randomly assigned to either the human-base or dog-base condition during the teaching phase; within each base condition, children were randomly assigned to read either *Berenstain Bears* or *First Animal Encyclopedia* during the priming phase. The procedure involved four distinct phases: teaching, priming, training, and test. We use the dog-base to illustrate below.

Teaching phase

The child and experimenter each received a line drawing of the base (e.g., a dog). The experimenter introduced a novel biological

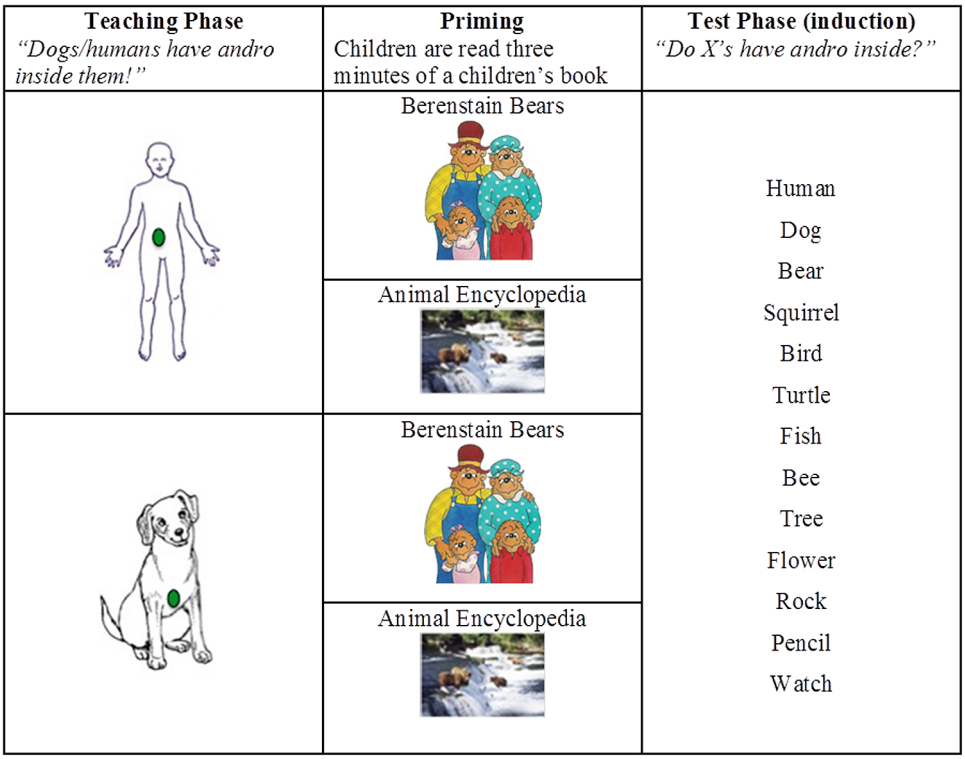

FIGURE 1 | Experimental design. During the teaching phase, children were presented with either a human or dog; during the priming phase children were read to from Berenstain Bears or Animal Encyclopedia. All children were presented with all target pictures during the test phase.

property (e.g., "Dogs have *andro* inside them. *Andro* is roundish, greenish, and it goes inside!"). She then handed the child a crayon, saying, "Look! I'm drawing *andro* in my picture of a dog! Will you draw *andro* in yours?"

Priming phase

At this point, the experimenter read a few pages of either *Berenstain Bears* or *First Animal Encyclopedia* to the child. After three minutes, the experimenter closed the book and put it away.

Training phase

Next, the experimenter engaged the child in two training trials, designed to clarify the task for the child and to convey that sometimes the puppets were right, but that sometimes they were wrong. (This training phase was developed in Herrmann et al., 2010). The experimenter told the child that she had brought with her some pictures and some "silly puppets." She explained that each puppet sometimes said the right thing, and sometimes was very silly, and that the child's job was to help her (the experimenter) figure out which puppet was right. She then placed one puppet on either side of the child's line drawing (e.g., dog) and initiated a brief puppet show, in which she posed questions and the puppets responded. To begin, she asked, "What do we have here?" One puppet asserted (correctly), "That's a picture of a dog!"; the other countered (incorrectly), saying, "No. That's not a picture of a dog!" The experimenter asked the child to decide which puppet was right (the first puppet) and to indicate their choice by pointing. Next, the puppets "spoke" again. This time, the first asserted (incorrectly), "That's a picture of a chair!" and the second countered (correctly), "No! That's not a picture of a chair!" Again, the child was instructed to point to the puppet that was correct (this time, the second puppet). If the child responded incorrectly, the experimenter repeated the puppet dialog and asked which puppet was right. If a child failed to respond correctly after three repetitions, the child was excluded from further analysis.

Test phase

To begin the test phase, the experimenter revealed all of the target photographs in random order, asking the child to identify each by name, and then providing feedback. She then shuffled the photographs and reminded the child, e.g., "Remember when we talked about *andro*? And we said that dogs (or people) have *andro* inside? Some other things have *andro* too. Let's look". She then introduced each target sequentially, in random order, with a finger puppet positioned on either side. For every question the experimenter posed (e.g., "What do you think? Do X's have *andro* inside?"), one puppet answered in the affirmative (e.g., "Yes! X's do have *andro* inside") and the other countered in the negative (e.g., "No! X's do not have *andro* inside"). The child's task was to decide which puppet was right. Response-neutral encouragement was offered after any response (e.g., "Okay! Good for you!"). The experimenter then introduced another target, this time flanked by a different pair of puppets, and so on. The order in which the puppet pairs

appeared and the order in which each "spoke" was counterbalanced. The experimenter recorded the child's response to each target.

RESULTS

The results, depicted in **Figure 2**, reveal that 5-year-old urban children responded to the distinctly different construals presented to them in the two books, and that these primes influenced their subsequent reasoning about a novel biological property. As predicted, children reading excerpts from *Berenstain Bears* showed the classic human-centered pattern, favoring humans over non-human animals as an inductive base. But those reading *Animal Encyclopedia* performed differently, providing no hint of the anthropocentric stance that, until now, has been considered the hallmark of their reasoning about the biological world.

We tailored our analyses to focus on three issues. For all analyses, $p < 0.05$ was set as the threshold for statistical significance. Moreover, the patterns exhibited by individual children converged with the mean patterns observed at each age.

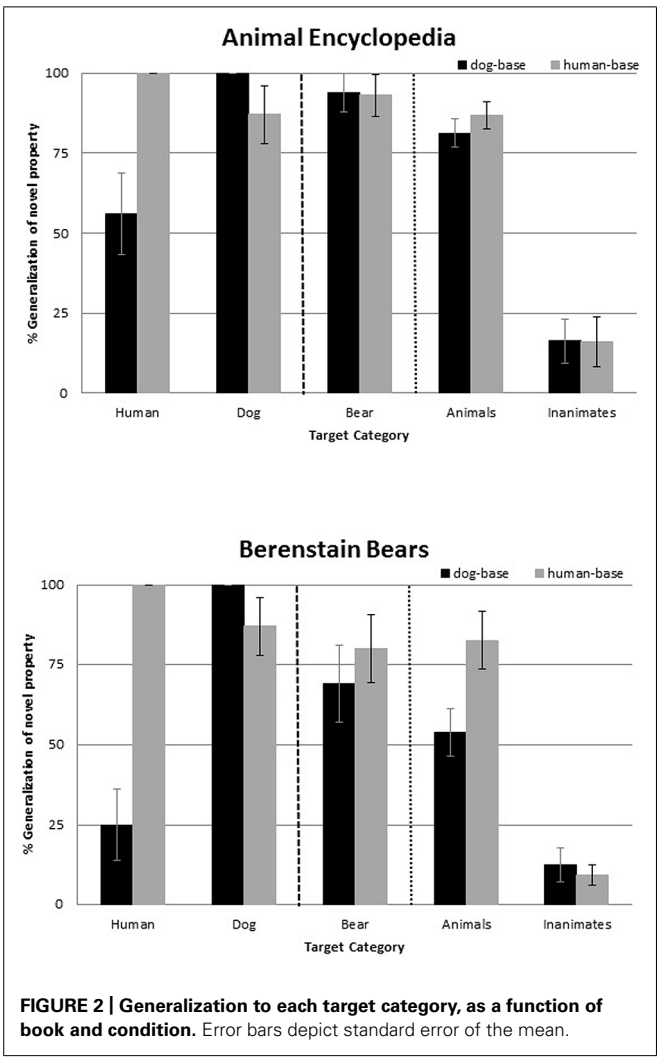

FIGURE 2 | Generalization to each target category, as a function of book and condition. Error bars depict standard error of the mean.

PROJECTING THE NOVEL BIOLOGICAL PROPERTY TO A NEW BEAR

First, we asked whether the way in which bears were represented in the book that they read influenced the likelihood that children would project a novel biological property to a new bear. To address this question, we considered children's tendency to extend the novel biological property (learned in the teaching phase) to the *bear* test item. An ANOVA using Base (human- vs. dog-base) and Book (*Berenstain Bears* vs. *Animal Encyclopedia*) as between-participants factors revealed an effect for Book, $F(1, 58) = 4.28$, $p < 0.05$. Children reading *Animal Encyclopedia* ($M = .94$, SD $= 0.07$) were more likely than those reading *Berenstain Bears* ($M = 0.74$, SD $= 0.07$) to extend the novel property to the bear test item.

To provide a more direct test of our hypothesis, we conducted planned contrasts within each book. As predicted, for children reading either book, projections from the *human* to the bear were uniformly high [0.93 (SD $= 0.26$) and 0.80 (SD $= 0.41$) for *Berenstain Bears* and *Animal Encyclopedia*, respectively, *ns*], but their projections from the *dog* to the bear revealed an impact of the book that they had read: Here, children reading *Animal Encyclopedia* were more likely to extend the property from a *dog* to the new bear ($M = 0.94$, SD $= 0.25$) than were children reading the *Berenstain Bears* ($M = 0.69$, SD $= 0.48$), $p < 0.05$. Thus, children reading the *Berenstain Bears* showed an asymmetry that favored reasoning from humans (over dogs) as a base, but those reading the *Animal Encyclopedia* revealed no asymmetry.

This reveals that the perspective portrayed in the book was sufficiently strong to influence children's tendency to extend a newly learned biological property to bears. Children who were primed with a book portraying bears realistically (as animals) adopted a biological stance, projecting the novel property from one animal (either a human or a dog) to the new bear presented at test. But children who were primed with a book portraying bears anthropomorphically adopted a human-centered reasoning pattern and were less likely to extend the novel property from one non-human animal (dog) to another (bear).

In the next analyses, we consider whether the book primes also influenced children's expression of the two patterns – asymmetries and generalization patterns – that have been taken as signatures of reasoning from an anthropocentric perspective (Carey, 1985; Ross et al., 2003).

ASYMMETRIES IN REASONING

Does the way in which bears were represented in the book that children read influence their tendency to project the novel biological property from *human* to *dog* and from *dog* to *human*? We predicted that children reading either book would be more likely to extend the property from a *human* to a *dog* than from a *dog* to a *human* (Carey, 1985; Herrmann et al., 2010), but that this asymmetry favoring humans would be less pronounced for children who had been primed with *Animal Encyclopedia* than *Berenstain Bears*. An ANOVA using Base (human- vs. dog-base) and Book (*Animal Encyclopedia* vs *Berenstain Bears*) as between-participants factors revealed a main effect for Base, $F(1,58) = 18.30$, $p < 0.0001$. Children were more likely to extend a novel property from a *human* to a *dog* ($M = 0.87$, SD $= 0.35$) than from a *dog* to a *human* ($M = 0.41$, SD $= 0.50$). This was mediated by an interaction

between Base and Book, $F(1,58) = 2.11$, $p = 0.152$, that fell short of statistical reliability but was consistent with the prediction that children primed with a biological construal (*Animal Encyclopedia*) would be less likely than those primed with an anthropocentric construal (*Berenstain Bears*) to favor humans over non-human animals (here, dog) in their reasoning.

We pursued this by conducting planned contrasts within each book. As predicted, children exposed to the anthropocentric book made significantly more projections from the *human* to the *dog* ($M = 0.87$, SD = 0.35) than from the *dog* to the *human* ($M = 0.25$, SD = 0.45), $p < 0.05$. This replicates the pattern reported in previous work with urban four- and 5-year-olds (Carey, 1985; Herrmann et al., 2010). But children exposed to the biological book revealed no such asymmetry, with no reliable difference in their projections from a *dog* to a *human* ($M = 0.56$, SD = 0.51) versus from a *human* to a *dog* ($M = 0.87$, SD = 0.35), *ns.*

GENERALIZATION PATTERNS TO OTHER ANIMALS AND TO INANIMATE OBJECTS

Finally, we focused on children's responses to the remaining targets, asking whether the way in which bears were represented in the book prime influenced their patterns of generalizing the novel biological property to other animals and to inanimate objects. We predicted that children reading either book would be more likely to generalize the property to other animals if it was introduced in conjunction with a *human* than a *dog* (Carey, 1985; Herrmann et al., 2010), but that this generalization pattern favoring humans would be less pronounced for children who had read the biologically oriented book than the anthropocentric book. For this analysis, any targets that were included in the previous analyses (bear, dog, human) were excluded. An ANOVA with Book (*Animal Encyclopedia* vs. *Berenstain Bears*) and Base (human-base vs. dog-base) as between-participant factors and Target category (animals vs. inanimates) as a within-participants factor revealed a main effect for Target category, $F(1, 58) = 196.369$, $p = 0.000$. Independent of the book they had read, children's projections to other animals were uniformly high and their projections to the inanimates were uniformly low. This was qualified by an interaction between Target category and Base, $F(1, 58) = 4.468$, $p < 0.05$, as well as a main effect for Book, $F(1,58) = 5.345$, $p < 0.05$: children reading *Animal Encyclopedia* were more likely than those reading *Berenstain Bears* to generalize the novel biological property. Moreover, as in the previous two analyses, the influence of the book prime was more pronounced for children reasoning from the *dog*- than from the *human-base.*

We pursued this by conducting planned comparisons of children's generalization patterns within each book. As predicted, those reading the anthropocentric book revealed the classic anthropocentric pattern: they were more likely to extend the novel property to other animals if it had been introduced on a *human* ($M = 0.83$, SD = 0.36) than a *dog* ($M = 0.54$, SD = 0.30), $p < 0.05$. But children reading the biological book showed a different pattern: their results reveal no evidence that humans served as a privileged inductive base. Instead, their tendency to extend the novel property to other animals was comparable, whether it had been introduced in conjunction with the human ($M = 0.87$, SD = 0.16) or the dog ($M = 0.81$, SD = 0.17), *ns.*

In sum, children were indeed sensitive to the distinctly different construals of animals offered in these two children's books, and this had consequences on their biological reasoning in a subsequent induction task. Children reading *Berenstain Bears* – a book filled with anthropomorphized images and information about bears – favored humans over non-human animals as an inductive base, replicating previous reports (Carey, 1985; Herrmann et al., 2010). In contrast, children reading *Animal Encyclopedia* – a book filled with realistic images and biological information about bears – revealed no anthropocentrism. Moreover, *Animal Encyclopedia* served as a more effective support for children's learning about biological properties of a new bear than did *Berenstain Bears.*

DISCUSSION

This experiment offers four insights into the influence of picture books in children's developing notions of the natural world. First, the results reveal that 5-year-old children's sensitivity to the representations of non-human animals in children's books is keen enough to influence their reasoning. Children who were primed with a book portraying bears realistically (as animals) adopted a biological stance, projecting the novel property from one animal (either a human or a dog) to other animals at test. But children who were primed with a book portraying bears anthropomorphically adopted a human-centered reasoning pattern and were less likely to extend the novel property from one non-human animal (dog) to others. Second, these results provide unambiguous evidence that the anthropocentric pattern of reasoning *typically* observed in urban 5-year-old children on the category-based induction task is not the only perspective available to them in reasoning about the biological world. Instead, the perspective they adopt is influenced by the way in which non-human animals are represented in a children's book they read moments earlier. Third, these results reveal that when we "humanize" non-human animals in our stories to young children, we do not promote learning about the biological world. Instead, anthropomorphizing non-human animals appears to have the opposite effect. This outcome is consistent with other recent work (Richert et al., 2009; Walker et al., 2012; Legare et al., 2013). Finally, these results have implications for promoting science learning in young children. If we understand the model(s) that children bring with them to their classrooms, we may be better able to promote their learning (Bang et al., 2007; National Research Council, 2007).

These results also provide insight into why anthropocentric patterns of reasoning about the biological world might emerge in urban 5-year-old children. We know that by 5 years of age, children are especially sensitive to cultural discourse about biological phenomena (Waxman et al., 2007). In urban communities, where direct contact with non-human animals is relatively limited (Rogoff et al., 2003) and where images of non-human animals in children's books, discourse, and media often take an anthropocentric cast (Marriott, 2002; Pentimonti et al., 2011; Dehghani et al., 2013), young children encounter considerable support (intended or not) for an anthropocentric perspective. The results of the current experiment reveal their sensitivity to these anthropocentric portrayals in their reasoning. We suspect that in rural communities, where children's engagement with the natural world is

less mediated by artifacts, exposure to anthropocentric images may exert less impact on children's developing notions of the biological world. A goal of our ongoing work is to ascertain whether rural children, or children from non-Western cultural communities, are less likely than their urban counterparts to adopt a human-centered perspective when exposed to anthropocentric media primes.

Another goal is to consider the impact of how animals are portrayed in other media designed for young children, extending the current results not only to other children's books but also to films. Additional research will also be required to ascertain which features of these books (e.g., text, illustrations) – separately or in combination – were most influential in shaping children's reasoning patterns and to discover how books written from the perspective of other cultural communities (c.f., Native American) might influence children's reasoning about the natural world.

In closing, the experiment reported here reveals that priming with children's books had a dramatic effect. Children primed with *Berenstain Bears* revealed the standard anthropocentric pattern. In contrast, children primed with *Animal Encyclopedia* adopted a biological reasoning pattern. This offers the first evidence of a distinctly biological reasoning pattern in urban 5-year-olds and suggests that they can move flexibly from a biological to a human-centered stance, depending upon the context at hand. Thus, children's books and other media are double-edged swords. Media may (inadvertently) support human-centered reasoning in young children, but may also be instrumental in redirecting children's attention to a biological model in which humans are one among the animal kinds.

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Let's look at leeks! Picture books increase toddlers' willingness to look at, taste and consume unfamiliar vegetables

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Repeatedly looking at picture books about fruits and vegetables with parents enhances young children's visual preferences toward the foods in the book (Houston-Price et al., 2009a) and influences their willingness to taste these foods (Houston-Price et al., 2009b). This article explores whether the effects of picture book exposure are affected by infants' initial familiarity with and liking for the foods presented. In two experiments parents of 19- to 26-month-old toddlers were asked to read a picture book about a liked, disliked or unfamiliar fruit or vegetable with their child every day for 2 weeks. The impact of the intervention on both infants' visual preferences and their eating behavior was determined by the initial status of the target food, with the strongest effects for foods that were initially unfamiliar. Most strikingly, toddlers consumed more of the unfamiliar vegetable they had seen in their picture book than of a matched control vegetable. Results confirm the potential for picture books to play a positive role in encouraging healthy eating in young children.

Keywords: exposure, picture books, fruit and vegetables, visual preference, willingness to taste, consumption

INTRODUCTION

Picture books provide a rich, indirect source of information about the world with which children can supplement the knowledge they acquire through personal experience. It is therefore of interest to ascertain what types of information children acquire from picture books, and under what circumstances children spontaneously transfer what they have learned from pictures to the real world. Previous research has established, for example, that 24-month-old infants generalize words that have been taught as labels for pictures to the objects themselves (Preissler and Carey, 2004; Ganea et al., 2008), while older preschoolers transfer information they have learned about the biological properties of animals in picture books to the animals themselves (Ganea et al., 2011). Such research has established a number of factors that influence the success with which children transfer their learning from pictures to the real world. First, the child must understand the symbolic relationship between pictures and the objects and events these represent; such an awareness of how pictures represent reality is first evident during the second year of life (Ganea et al., 2009). Second, transfer of learning is best supported by pictures that closely resemble their real-world referents; thus, photographic images facilitate generalization of learning relative to less realistic images (Ganea et al., 2008). Third, generalization of learning is more likely to occur in similar contexts to those in which the learning occurred. In a study by Simcock and Dooley (2007), for example, infants showed lower levels of imitation of an action sequence toward an object when they moved to a different test room between seeing the action in a picture book and being presented with the object themselves.

Previous research by our group has built on this work to investigate whether looking at picture books about healthy foods affects preschoolers' behavior toward the foods depicted. Houston-Price et al. (2009a) provided the parents of 17- to 27-month-old toddlers with books containing photographs and information about fruits and vegetables and asked them to read these with their children on a daily basis for 1, 2, or 3 weeks. In this study, the impact of the books was measured in terms of children's visual preferences for the exposed foods. When children were shown pairs of pictures of foods, such that one food in each pair had been included in the child's book and one had not, they spent significantly longer looking at the fruits and vegetables they had seen in their books. The largest impact on looking time was shown by children whose parents had been asked to read the book with them every day for a fortnight (who actually recorded completing an average of nine readings). Importantly, a looking preference for the exposed foods was evident both when the pictures presented in the visual preference test were identical to those children had seen in their books and when new pictures of the exposed foods were used at test. This led Houston-Price et al. (2009a) to argue that children's longer looking times toward the target foods in this study were not solely driven by the perceptual familiarity of the exposed pictures, but rather reflected children's interest in the foods themselves.

To test this hypothesis, Houston-Price et al. went on to explore whether looking at picture books about fruits and vegetables influences children's willingness to taste these foods, as well as their interest in looking at them (Houston-Price et al., 2009b). Parents were asked to read a picture book to their 21- to

24-month-old children every day for a fortnight. The books featured two familiar foods (e.g., sweetcorn and strawberries) and two unfamiliar foods (e.g., radishes and lychees). After the reading period, children took part in a taste test, in which they were offered a plate of four vegetables, followed by a plate of four fruits. Each child had seen pictures of two of the four items on each plate in their books. The children were encouraged to taste all of the foods presented and the order in which foods were tasted was recorded. Children tasted significantly more of the foods that were expected to be familiar to them, displaying a neophobic pattern of behavior that is typical of this age group (Cashdan, 1994; Raudenbush and Frank, 1999; Cooke et al., 2003). However, the order in which children approached the foods that were not expected to be familiar was affected by the book they had seen. Children tasted the unfamiliar fruit they had seen in their book before the unfamiliar fruit they had not seen in their book. This study therefore provides preliminary evidence that picture books can influence the foods that children are willing to taste.

In our view, these findings are worth pursuing, as they suggest that a positive attitude toward healthy foods might be engendered in children before they have even tasted them. This is important because, without prior visual exposure, children need to taste a new food between 8 and 15 times before they will accept it into their diet (Birch and Marlin, 1982; Birch et al., 1987; Sullivan and Birch, 1990; Wardle et al., 2003a,b; Lakkakula et al., 2010). It is often difficult for parents to provide this number of exposures, given the challenging behavior they are confronted with when they ask their toddler to try a new food. In fact, parents typically offer a new food to their child on only three to five occasions before giving up (Carruth and Skinner, 2000; Carruth et al., 2004). As a result, children not only fail to receive sufficient exposures to new fruit and vegetables for these to become accepted into their diet, but parents also tend to fall back on foods that are known to be liked by the child, reinforcing the child's desire for these (Nicklaus, 2011). If children's willingness to taste a new food is enhanced by a period of picture-book exposure prior to introducing the food at mealtimes, parents' efforts to provide their children with a varied and healthy diet might perhaps be facilitated.

However, while picture books were found to have a positive effect on children's willingness to taste the unfamiliar fruits in Houston-Price et al.'s (2009b) study, it is important to note the unexpected negative result reported in the same study. Although children were more willing to taste the foods that were expected to be familiar to them, the vegetables that fell into this category (carrots and sweetcorn) were *less* likely to be tasted if children had seen these in their book. That is, while looking at pictures of lychees for 2 weeks increased children's willingness to taste these in a subsquent taste test, looking at pictures of carrots for the same period had the opposite effect. Work is therefore needed to establish the types of foods for which picture-book exposure has the desired effect. It is interesting to note that a similar decrease in desire for a food is sometimes found to follow repeated taste exposures. For example, when Liem and Zandstra (2009) asked 12-year-old children to consume the same unfamiliar snack food every day for 3 weeks, children's desire for the snack declined over time due to the monotony of eating the same food every day. Even after a single lunch session, preschoolers and adults may display "sensory specific satiety," a decrease in the reported pleasantness of the recently consumed flavor or texture (Birch and Deysher, 1986; Rolls, 1986). One account of these findings proposes that over-exposure to a food devalues its worth (Brondel et al., 2007). Brondel et al. (2007) asked 144 adults to evaluate the pleasantness of six different foods before and after they were invited to consume these foods "*ad libitum*." Individuals consumed greater quantities of the foods rated as having higher hedonic value but the pleasantness ratings given to these foods decreased following consumption relative to uneaten foods. Thus, although individuals choose to eat the foods that they rate highly in terms of hedonic liking, their desire for these foods lessens as they gain exposure to them. While no measure was taken of the extent to which children liked the familiar foods in Houston-Price et al.'s (2009b) study, it is possible that children's disinterest in tasting the exposed familiar vegetables might have a similar cause; as with repeated taste exposure, repeated visual exposure to foods that are already liked and/or familiar might decrease a child's interest in consuming them. The aim of the studies reported here was therefore to examine whether a child's prior familiarity with or liking of a fruit or vegetable, as reported by parents, moderates the extent to which picture-book exposure affects the child's willingness to look at and taste the foods depicted.

We report two experiments, in each of which a picture book about a liked, disliked or unfamiliar fruit or vegetable was repeatedly read to 18- to 24-month-old children by their parents. Experiment 1 examined the impact of the books on children's visual preferences for exposed ("target") foods vs. non-exposed ("control") foods. As in Houston-Price et al. (2009a), we compared looking times toward both seen pictures and new pictures of the target foods. Experiment 2 investigated how a food's initial status impacts on the books' effectiveness as a means of increasing children's willingness to taste target foods. Based on the findings of Houston-Price et al. (2009b), we hypothesized that, in both studies, unfamiliar foods would be subject to stronger exposure effects than familiar (liked and disliked) foods, and that the intervention would be least effective for foods that were already liked.

EXPERIMENT 1

METHOD

Participants

One hundred and fifty-four toddlers aged between 19 and 26 months, all reported to have normal hearing and vision, and their parents were recruited from the University of Reading's Child Development Group database of families who had expressed an interest in taking part in research. Of these, 22 children were excluded for failing to meet criteria for participation (as detailed in the Procedure) and 13 families withdrew from the visual preference test due to ill health or other commitments. The final sample consisted of 119 children (60 males and 59 females) with a mean age of 21 months 26 days (range 19 months 24 days to 26 months 15 days). Demographic information (provided by more than 90% of those who completed the study) indicated that 87% of participating families were white and 76% included at least one parent educated to graduate level.

Materials

Previously-collected ratings of toddlers' familiarity with and liking of 39 fruits and 48 vegetables on a "Food Familiarity and Liking Questionnaire" (FFLQ) were used to select the food items for this study. These ratings were provided by the parents of 93 children (57 boys and 36 girls) aged between 16 and 24 months, also recruited from the University of Reading's Child Development Group database, between 2006 and 2009. The six vegetables identified as the most liked, the most disliked and the most unfamiliar to children according to these ratings were selected as stimuli for the corresponding initial status conditions of the current study (see Supplementary Material). Similarly, the six most liked fruit and the six most unfamiliar fruit were selected for the corresponding fruit categories. As it was not possible to identify six fruits that were commonly disliked by children at this age, there was no "disliked fruit" condition in this study.

An individual picture book was produced for each of the fruits and vegetables in each initial status set (an example of a book can be seen in Supplementary Material). The layout and format of each book was identical. Books were A5 in size and constructed of strong card; they were brightly colored and written in a style suitable for 18- to 24-month-old children. Books consisted of seven pages of pictures and information about the target fruit or vegetable. The first page of each book provided instructions to parents about how to read the book and the last page contained a tick-sheet reading record upon which parents were asked to note how many times they looked at the book with their child. On each of the remaining five pages a large photograph and information about the chosen fruit or vegetable was displayed. Photographs were matched for type across books and recounted the progression of the fruit or vegetable from "farm to fork" (i.e., from what the food looks like when growing in the field to its appearance when presented for eating). The supporting sentences described the pictures and provided additional information about the food shown (see Supplementary Material).

Visual preference testing took place in a three-sided visual preference booth with a large back-projection screen measuring 1.5×0.6 m on the rear wall. A chair for parents to sit on, while holding the child on their lap, was placed one meter away from the screen. Adobe Photoshop 4.0 was used to generate 10 different 320×200 pixel, 256-color images of each fruit or vegetable against a white background. Five of the images of each food were identical to those displayed in the picture books, while five were new but easily-recognizable pictures of the food (subsequently referred to as "seen pictures" and "new pictures" respectively). Images were displayed side by side on the screen at infant eye height; images measured 24×16 cm and were separated by a gap of 25 cm. A 24×40 cm image of a popular character from a children's television programme was used to refocus children's attention to the center of the screen between trials. Two auditory tokens of the word "Look" were recorded by an adult female voice in infant-directed speech, one to be used during experimental trials, the other to be used between trials to attract infants' attention to the screen. The booth had low-level lighting so that infants' looking direction could be captured by three infrared cameras situated immediately above the two image locations and central point of the screen.

Procedure

Parents were contacted by telephone and given a brief description of the experiment. If they gave consent for their child to participate, the child was immediately randomly assigned to one of five initial status groups: Liked Vegetable ($N = 24$), Disliked Vegetable ($N = 23$), Unfamiliar Vegetable ($N = 24$), Liked fruit ($N = 24$), and Unfamiliar Fruit ($N = 24$). During the initial telephone call, the researcher read out the list of six foods in the initial status category to which the child had been assigned and asked the parent whether the child liked, disliked or had not tried each food. If parents reported that the child's familiarity with or liking of two or more of the six foods matched the expected status of the food, one of these was randomly selected to be the target (exposed) food and another was randomly selected to be the control (non-exposed) food for that child. If fewer than two foods matched the status of the child's allocated group, the child was not included in the study. An appointment was made for parents and children to take part in a visual preference test at the School of Psychology and Clinical Language Sciences at the University of Reading a few weeks later.

Parents were then sent a picture book about the child's target food in the post, with instructions to read the book with their child for approximately 5 min a day for 14 days. Parents were invited to use the words provided and their own words when reading the book and were asked to complete the tick sheet each time they read it. If, after receiving the book, a parent asked to rearrange their appointment for the visual preference test, they were asked to stop reading the book and to resume reading it nearer to the visit date, ensuring that the child received a total of 14 exposures. On three occasions, the child had already seen the book 14 times before their visit was rescheduled; in these cases, parents were asked to take a break from looking at the book and to resume reading it again 3 days before their visit.

Parents visited the University on weekday mornings or afternoons at times they found convenient and when the child was alert but not hungry. On arrival, the experimenter spoke with the parent and played with the child for a few minutes so that they felt relaxed in the laboratory environment. Parents were then invited to sit with their child on their lap in the visual preference booth for the preference test. Parents were asked to keep their eyes closed throughout the test period, to ensure they did not influence their child's behavior. The child was shown a series of trials, each lasting 7 s. On each trial, a pair of pictures was shown side-by-side on screen; one was a picture of the target food that the child had been exposed to in their picture book, the other was a picture of the control food selected from the same initial status set. Picture pairs were matched for type, such that both showed a food growing on the plant, for example. Children were quasi-randomly assigned to take part in a "seen" or "new" pictures condition. The first 60 participants recruited took part in the "seen pictures" condition, and saw the same five pictures of the target food in their preference test that they had seen in their picture books. Remaining participants ($N = 59$) took part in a "new pictures" condition, and saw five new pictures of their target food during their preference test. The five pairs of pictures were displayed twice, once with the target food on the left side of the screen and once with the target food on the right side of the screen, making 10 trials in total. Picture pairs

were shown in a random order. One hundred milliseconds after the onset of each trial, the audio instruction "*Look!*" was played from speakers situated above and below the screen to direct children's attention to the screen. The researcher controlled the start of each trial and, when necessary, played a second instruction to "*Look!*" between trials to attract the child's attention toward the screen.

Coding and measures

Video recordings of children's fixation on each image during each trial were coded off-line on a frame-by-frame basis using Observer 5.0 Software (http://www.noldus.com/human-behaviorresearch/products/theobserver-xt). Each frame was coded as a look to the left image, right image, between images or away from the screen. Coders were blind to the condition of the child they were coding and to the side of the screen on which the target food was displayed. One researcher coded the full set of recordings and, to check coding reliability, a random sample of 30% of recordings ($N = 42$) was independently coded by a second coder. The mean Cohen's Kappa for concordance between the two scorers' codes for each frame of these recordings was 0.92 (range = 0.78–1.00).

The measure of visual preference used was the "total looking time difference," the mean difference in the time children spent looking at the target picture and the control picture on each trial, averaged over the 10 test trials and across participants. Thus, mean values greater than zero indicate that children spent more time looking at the target food than the control food. To test the data's suitability for parametric analyses, we examined the standardized residuals for the overall 2 × 3 × 2 ANOVA (food type x initial status set x seen/new pictures), which confirmed that the error terms for the total looking time difference measure followed a pattern of normal distribution [Shapiro-Wilk's $W_{(119)} = 0.99$, $p = 0.50$].

RESULTS AND DISCUSSION

According to the reading records provided by parents, there was a large range in the number of readings provided. Although books were read an average of 14.03 times ($SD = 6.20$), the smallest number of exposures was 6, while two children saw their book between 40 and 50 times. As there was no correlation between the number of exposures provided and the measure of total looking time difference, $r_{(118)} = -0.02$, $p = 0.80$, and as the two children with the highest number of exposures were not outliers on this measure, we did not exclude any participants on the basis of the number of readings experienced.

Mean looking times toward the target and control foods and mean total looking time differences for the children in each condition can be seen in **Table 1**.

We first sought to confirm previous findings that picture-book exposure creates a visual preference for target foods. When total looking time differences were averaged across participants in all conditions ($M = 548$ ms, $SD = 796$), a one sample t-test confirmed that children looked longer at target foods than control foods, $t_{(118)} = 7.51$, $p < 0.001$. When the same tests were run for the children in each of the initial status groups separately, a significant looking preference for the target foods was found in all three groups [liked foods: $M = 300$ ms, $SD = 533$ ms, $t_{(47)} = 3.90$, $p < 0.001$; disliked foods: $M = 501$ ms, $SD = 882$ ms, $t_{(22)} = 2.72$ $p = 0.012$; unfamiliar foods: $M = 817$, $SD = 896$ ms, $t_{(47)} = 6.32$ $p < 0.001$]. Similarly, children looked longer at target foods whether they saw the same pictures they had seen in their picture books, $t_{(58)} = 6.80$, $p < 0.001$, or new pictures, $t_{(59)} = 3.96$ $p < 0.001$.These results indicate that, regardless of the initial status of the target food or the type of picture shown in the test phase, the picture books enhanced children's visual attention to the exposed foods relative to the non-exposed foods of the same initial status.

Table 1 | Mean looking times toward target and control foods and mean total looking time differences (target—control) for the children in each condition of Experiment 1.

Condition	*N*	Looking time to target food Mean (*SD*)	Looking time to control food Mean (*SD*)	Total looking time difference Mean (*SD*)
SEEN PICTURES				
Liked fruit	12	3146 (343)	2725 (321)	421 (520)
Liked vegetables	12	3016 (481)	2833 (316)	183 (639)
Disliked vegetables	11	3546 (492)	2631 (477)	915 (881)
Unfamiliar fruit	12	3424 (701)	2361 (447)	1063 (1014)
Unfamiliar vegetables	12	3684 (526)	2299 (443)	1385 (876)
All foods	59	3360 (562)	2569 (444)	791 (893)
NEW PICTURES				
Liked fruit	12	3002 (367)	2545 (432)	457 (511)
Liked vegetables	12	2786 (468)	2646 (248)	140 (434)
Disliked vegetables	12	2738 (474)	2616 (625)	122 (723)
Unfamiliar fruit	12	2978 (463)	2511 (437)	467 (678)
Unfamiliar vegetables	12	2853 (624)	2500 (433)	353 (623)
All foods	60	2871 (481)	2563 (439)	308 (602)

To explore the impact of food type (fruit or vegetable), initial status (liked, disliked, or unfamiliar) and picture type (seen or new) on children's looking behavior, the data were entered into a 2 × 3 × 2 ANOVA. There was no main effect of food type, $F_{(1,\ 109)} = 0.36$, $p = 0.55$, and no interactions between food type and initial status set, $F_{(1,\ 109)} = 1.73$, $p = 0.19$, food type and picture type, $F_{(1,\ 109)} = 0.79$, $p = 0.38$, or food type, initial status set and picture type, $F_{(1,\ 109)} = 0.38$, $p = 0.54$. The impact of the picture books was equivalent whether children saw pictures of fruit or vegetables.

In contrast, the hypothesized influence of children's initial familiarity with or liking for the foods was seen. There was a significant main effect of the initial status of the target food, $F_{(2,\ 109)} = 6.35$, $p = 0.002$. As shown in **Figure 1**, children's preference for the target food was strongest for initially unfamiliar foods and weakest for initially liked foods. *Post-hoc* tests showed that total looking time differences differed between the liked and unfamiliar conditions (Scheffe, $p = 0.002$), with no significant differences between the liked and disliked conditions (Scheffe, $p = 0.54$) or the disliked and unfamiliar conditions (Scheffe, $p =$

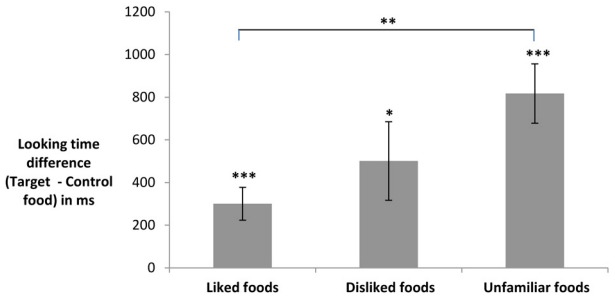

FIGURE 1 | Mean total looking time differences (in ms) for initially liked, disliked, and unfamiliar foods. Differences greater than 0 ms indicate that children looked longer at target than control foods. One-sample *t*-tests against chance (0): $^{*}p = 0.02$, $^{***}p < 0.001$. Pairwise comparison: $^{**}p = 0.002$.

0.22). When the children in the liked and disliked initial status conditions were combined to form a "familiar food" group, an independent *t*-test revealed that children's total looking time differences toward unfamiliar foods ($M = 817$, $SD = 896$) were significantly larger than those toward familiar foods [$M = 365$, $SD = 667$; $t_{(81)} = 2.98$, $p = 0.004$]. Thus, while picture book exposure enhanced attention toward target foods for children in all conditions, the intervention was more effective when children read about unfamiliar foods than when they read about foods that were already known to them or liked by them.

The ANOVA also tested the impact of presenting seen pictures or new pictures of the target foods at test. There was a significant main effect of picture type, $F_{(1,\ 109)} = 13.06$, $p < 0.001$; children showed a greater preference for their target food when presented with seen pictures of this food ($M = 791$ ms, $SD = 894$ ms) than when presented with new pictures ($M = 308$, $SD = 602$ ms). There was also a significant interaction between picture type and initial status set, $F_{(2,\ 109)} = 4.15$, $p = 0.018$; *post-hoc* t-tests established that the larger exposure effect among children who saw seen pictures at test was true for foods that were initially disliked, $t_{(21)} = 2.37$ $p = 0.028$, or unfamiliar, $t_{(46)} = 3.50$ $p = 0.001$, but not for foods that were initially liked, $t_{(46)} = 0.023$ $p = 0.98$. Thus, while the intervention had a positive impact on children's interest in looking at the target food regardless of the pictures presented at test, the effect was stronger for previously seen pictures when foods were initially disliked or unfamiliar.

In summary, the results of Experiment 1 indicate that the impact of picture-book exposure on children's visual preferences varies according to the initial status of the food presented in the book—with the strongest effects for initially unfamiliar foods—and the stimuli used to assess preferences at test. Importantly, in no condition was exposure found to have a negative effect upon children's looking behavior. The finding that exposure effects were greater when the preference test used the same pictures shown in children's picture books suggests that perceptual familiarity was a factor in children's behavior in this study (Zajonc, 1968, 2001; Bornstein and D'Agostino, 1994; Monahan et al., 2000). However, as positive exposure effects were also found for pictures that had not been seen before, the intervention may also have influenced children's interest in the depicted foods themselves. Experiment 2 set out to directly test this possibility by exploring whether looking at a book about a food affects children's behavior toward the food itself. Again, we manipulated the food's initial status in order to elucidate the effects of the book on children's behavior toward initially liked, disliked and unfamiliar foods.

EXPERIMENT 2

Experiment 2 examined children's willingness to taste an initially liked, disliked or unfamiliar vegetable after looking at a picture book about the food for 2 weeks, in comparison to a control food of the same initial status. This study focused solely on vegetables on the grounds that: (a) Experiment 1 found no differences in the effects of the intervention for fruits and vegetables; and (b) as children's least-favored food group, vegetables are a particular challenge for healthy eating interventions (Cashdan, 1998; Skinner et al., 2002; Cooke and Wardle, 2005). After looking at a picture book with parents for 2 weeks, children took part in a laboratory taste test, in which they were offered both the target vegetable they had seen in their book and a non-exposed control vegetable of the same initial status. Willingness to taste the foods was measured in terms of whether a food was tasted, the order in which the two foods were tasted and the encouragement required to persuade the child to taste the food. We also measured the amount of each food consumed. We hypothesized that children would be more willing to taste target foods than control foods, but that the strength of the exposure effect would be moderated by the food's initial status: we expected the strongest effect to be seen for initially unfamiliar foods, and the weakest effect for foods that were already liked.

Experiment 2 additionally examined the accuracy of parents' reports' of children's food likes and dislikes. While parents of children under two are typically present at their children's mealtimes and would be expected to know which foods the child has eaten and their likes and dislikes, previous research has produced mixed results with regard to the accuracy of parental reports. Studies using standard free-recall methods have found that parents overestimate infants' energy and nutrient intake (Baranowski et al., 1991; Fisher et al., 2008), while those using closed-recall methods have found parents to make accurate assessments of their child's fruit and vegetable intake (Linneman et al., 2004). Experiment 2 explored parents' ability to accurately report which vegetables are liked and disliked by their child; we recorded children's eating behavior when they were presented with a pair of foods, one reported to be liked and one reported to be disliked by parents. We hypothesized that children would be more willing to taste the foods that were reported to be liked and would consume greater quantities of these foods.

METHOD

Participants

Sixty-eight families with children aged between 20 and 24 months were recruited from the University of Reading's Child Development Group database. One child failed to meet the inclusion criteria (see below) and seven families withdrew from the study due to ill health or inability to visit the University for testing. Sixty infants (35 males and 25 females) completed the study, with a mean age of 22 months and 9 days (range 20 months 26 days to

24 months 0 days). Data from three participants (one in each of the liked, disliked and unfamiliar initial status conditions) were excluded from analyses because parents contravened instructions during the test session ($N = 2$) or because the parent changed her report about the initial status of the target vegetable ($N = 1$). Demographic information was provided by all parents; 88% of families were white and 78% came from a household where at least one parent was educated to graduate level. Mothers brought their children to the University for the test session in all but three cases, when other close relatives brought the child. Travel expenses were provided and children were given a certificate and a T-shirt if it was their third visit to the University to participate in a study.

Materials

A short-form parent-report "Vegetable Liking and Familiarity Questionnaire" (VLFQ) was created to assess children's familiarity with and liking of 16 different vegetables. These included the five most liked, disliked and unfamiliar vegetables on the original FFLQ (see Experiment 1), after foods that were deemed unsuitable for the taste test were excluded. The VLFQ additionally included spinach, a food that was reported to be unfamiliar to the majority of children on the FFLQ and liked and disliked equally by the remainder (see Supplementary Material for the list of vegetables included). For each vegetable listed, parents were asked to indicate whether the food was liked, disliked or unfamiliar to their child.

A picture-book was produced for each of the vegetables on the VLFQ, with the same layout and format as for Experiment 1 (see Supplementary Material for an example).

Four foods were prepared for each child's taste test, two for the Parent Report Check (one liked, one disliked) and two for the Exposure test (the target food and control food). In addition, two portions of a different vegetable were prepared for the parent to consume, so that the child would not be eating alone (see Houston-Price et al., 2009b). A small portion of each food (equivalent to one teaspoonful) was prepared, so that children could consume any or all of the foods offered without their appetite being affected. Vegetables were washed and presented either raw or cooked, and either sliced or whole, as appropriate. All vegetables were prepared within an hour of the test session and were served at room temperature. To prevent disliked foods "contaminating" liked foods by touching them (Brown and Harris, 2012), each vegetable was served on a separate plate.

Procedure

Parents were contacted by telephone and given a brief overview of the experiment. If a parent gave consent to their participation, the child was randomly allocated to one of three initial status conditions (liked, disliked, or unfamiliar), with equal numbers in each condition. The experimenter then verbally administered the VLFQ, asking parents whether their child liked, disliked or had not tried each vegetable listed. For each child, two vegetables were randomly selected from those for which the parent's responses matched the initial status set to which the child had been assigned; these became the target (exposed) and control (non-exposed) foods for that child. Children who were reported to have fewer than two vegetables in the assigned category were excluded from the study ($N = 16$). Parents were then asked to identify a liked and disliked vegetable by means of the following question, "Of all the vegetables you can think of, is there one that you know your child enjoys eating and one that you know they do not enjoy?" The two foods identified by parents were used for that child's Parent Report Check. If the parent named a food that had been selected as the target or control food for the Exposure test, a replacement target or control food was randomly assigned from the foods remaining of that status. Finally, parents were asked whether they would be happy to eat a piece of cucumber (and, if not, some spinach, red pepper, lettuce, or green beans) during the taste test, to help their child feel comfortable about eating in the test environment.

Parents were sent a picture book about their child's target vegetable in the post and were asked to read this with their child for approximately 5 min a day every day for 2 weeks, exactly as in Experiment 1. As before, if parents rescheduled their test date due to unforeseen circumstances such as ill health, they were asked to provide only 14 readings before the rescheduled visit. If the book had been read 14 times before the need to reschedule occurred ($N = 2$), parents were asked to carry out three refresher readings on the 3 days prior to their visit.

Parents brought their child to the University to take part in the taste test at a time when the child was alert and likely to be prepared to eat, typically mid- or late morning or mid- or late afternoon. On arrival at the University, parents were asked to complete the consent form while the researcher played with the child. Parents and children were then taken to the food tasting lab. The child was seated at a low table, with the parent and experimenter seated close by. The parent was reminded about the vegetable that they had agreed to taste and instructed that they should select that vegetable from the tray and should not point to, touch or encourage the child to eat any of the other foods on the tray, other than to repeat requests made by the experimenter. If the child offered the parent a food to eat, the parent was asked to replace it on the child's plate.

Each child took part in the Parent Report Check followed by the Exposure Test. For the Parent Report Check, the researcher brought in a tray containing three small plates; these held the liked and disliked vegetables, as reported by parents, and the food that the parent had agreed to eat. The researcher offered the tray to the parent and parents took the plate containing their designated food. The two plates containing the child's liked and disliked vegetables were then placed in front of the child in fixed side-by-side locations indicated by marked circles on the table. The researcher said to the child, "Here are two vegetables. Which would you like to eat?" If the child tasted a food, the researcher invited them to try the other food. If the child refused to try either vegetable, the researcher named each food and again asked the child which food they would like to try. Children were invited to try each vegetable up to three times. After a period of 5 min (or earlier if the child had eaten both foods or refused to eat any more), the plates were removed.

The Exposure Test followed exactly the same procedure. The parent was offered a tray containing the parent's vegetable and child's target and control vegetables. The child's target and control

vegetables were placed on the table and offered to the child as described above. Side of food presentation was fully counterbalanced within trials (so that the liked and disliked and target and control vegetables were placed equally often on the left and right sides) and across trials (so that the target vegetable was placed equally often on the side on which the liked and disliked vegetable had been placed in the previous trial). The test session was coded on-line by the researcher and video-recorded for the purposes of second-coding.

Coding

The experimenter recorded children's behavior toward the two foods during each test trial. "Willingness to taste" was coded in terms of three behaviors: (i) whether each food was tasted; (ii) the order in which foods were tasted; and (iii) the encouragement required to persuade the child to taste each food. Tasting was coded when the child placed the food on their lips or tongue, whether the food was subsequently spat out or swallowed. The encouragement required to persuade the child to taste the food was rated on a 5-point scale (1 = very easy to persuade child; 2 = quite easy; 3 = OK; 4 = quite difficult; 5 = very difficult, could not persuade child). "Amount consumed" was coded as a proportion of the portion provided, again using a 5-point scale (0 = none, 1 = nibble, 2 = less than ½tsp, 3 = ½tsp, 4 = whole portion).

As the experimenter was not blind to the liked/disliked or target/control food on each trial (due to the need to counterbalance the side of food presentation), a second blind coder independently coded 20% of the recorded test sessions ($N = 12$). This second coder noted that, while the video footage provided a good view of which foods were tasted, the camera angle and image resolution made it difficult to make fine-grained assessments of the encouragement required to persuade the child to taste the food and the amount of food consumed. The second coder therefore used only a 3-point scale to rate these behaviors (Encouragement required: 1 = easy to persuade, 2 = OK, 3 = difficult; Amount consumed: 1 = none, 2 = some, 3 = all) and the first coder's ratings were collapsed onto the same 3-point scale for reliability checks. Cohen's Kappa statistics for inter-rater reliability ranged from 0.72 to 1.00, representing a high level of agreement. To benefit from the more sensitive coding scheme used by the first coder, the first coder's ratings were used in analyses.

RESULTS AND DISCUSSION

According to the reading records provided by parents, children saw their book an average of 14.9 times ($SD = 9.9$) during the exposure phase but, as in Experiment 1, the number of readings varied widely between participants. No child received fewer than 9 readings but one child asked for the book to be read multiple times each day and accrued 84 presentations. As there were no correlations between the number of readings and the continuous measures collected in this study, and as this child was not an outlier on any measure, no participant was excluded from analyses on the basis of the number of readings experienced.

Parent report check

Table 2 presents the results of the parent report check trial. Of the 57 participants, 21 children tasted both the "liked" and "disliked" vegetables, 24 tasted only the liked food, 4 tasted only the disliked food, and 8 tasted neither. A chi-square test showed that there was a significant association between whether children tasted a food and whether it was reported to be liked or disliked by the parent, $\chi^2_{(1)} = 15.41$, $p < 0.001$; more children tasted the food reported to be liked. Of the 49 children who tasted at least one food on this trial, 38 tasted the liked vegetable first and 11 tasted the disliked vegetable first. A binomial test confirmed that significantly more children tasted the liked vegetable first ($N = 49$, $p < 0.001$).

We also compared the encouragement required to persuade children to taste the foods reported to be liked and disliked (see **Table 2**). A Wilcoxon signed ranks test confirmed that significantly less encouragement was required to persuade children to taste the vegetable that was reported to be liked ($Z = -5.15$, $p < 0.001$). Finally, there was a significant difference in the amount of the two foods consumed; children ate more of the liked vegetable than the disliked vegetable ($Z = -5.03$, $p < 0.001$).

These analyses show that, in line with the findings of Linneman et al. (2004), parents of young children can accurately report on the vegetables their children like and dislike. Compared to the food reported to be disliked, the food that was reported to be liked was tasted by more children, tasted first by more children, required less encouragement to be eaten and was consumed in greater quantities.

Exposure test

Table 3 presents the results of the exposure test trial for the children in each initial status condition separately, and for all children combined. Of the 57 children who took part, 30 tasted both the target and control foods, 13 tasted only the target vegetable, 6 tasted only the control vegetable, and 8 tasted neither. A chi-squared test found no association between whether a vegetable had been exposed or not and whether it was tasted in the test trial, $\chi^2_{(1)} = 3.29$, $p = 0.07$. We explored whether this pattern was true for each of the three initial status groups using a 2 (target vs. control) × 3 (initial status category) × 2 (whether the food was tasted) log-linear analysis. This found no main effect of exposure, $G^2_{(1)} = 2.04$, $p = 0.15$, no main effect of initial status condition, $G^2_{(2)} = 2.04$, $p = 0.36$, and no interaction between exposure and initial status category, $G^2_{(7)} = 4.14$, $p = 0.76$. Thus, whether children tasted a food or not was not influenced by whether it had been seen in their picture book or its initial status as liked, disliked or unfamiliar.

Table 2 | Number of children who tasted the foods reported by parents to be "liked" and "disliked," the number who tasted each of these foods first, and mean ratings of the degree of encouragement required to persuade the child to taste each food (1 = very easy, 5 = very difficult) and amount of each food consumed (0 = none, 4 = whole portion).

Food	*N* who tasted this food	*N* who tasted this food first	Encouragement required Mean (*SD*)	Amount consumed Mean (*SD*)
"Liked"	45	38	2.3 (1.7)	2.5 (1.7)
"Disliked"	25	11	4.3 (1.4)	0.5 (1.1)

Table 3 | Number of children who tasted the target and control foods, the number who tasted each of these first, and mean ratings of the degree of encouragement required to persuade the child to taste each food (1 = very easy, 5 = very difficult) and amount of each food consumed (0 = none, 4 = whole portion), for each initial status condition and for all groups combined.

Initial status condition	*N*	Food	*N* who tasted this food	*N* who tasted this food first	Encouragement required Mean (*SD*)	Amount consumed Mean (*SD*)
Liked	19	Target	15	9	2.5 (1.8)	2.2 (1.7)
		Control	13	7	3.0 (1.9)	1.9 (1.8)
Disliked	19	Target	13	9	3.9 (1.5)	0.7 (1.0)
		Control	10	7	4.2 (1.4)	0.5 (1.0)
Unfamiliar	19	Target	15	12	2.4 (1.8)	2.0 (1.7)
		Control	13	5	3.7 (1.7)	1.0 (1.6)
All	57	Target	43	30	2.9 (1.8)	1.6 (1.6)
		Control	36	19	3.6 (1.7)	1.1 (1.6)

The order in which children tasted the target and control vegetables was also examined (see **Table 3**). Of the 49 children who tasted at least one food, 30 tasted the target vegetable first and 19 tasted the control vegetable first, a distribution that was not different to chance in a binomial test ($N = 49$, $p = 0.15$). The same pattern held for each initial status condition; there was no association between a food's initial status as liked, disliked or unfamiliar and whether the target or control food was tasted first, $\chi^2_{(2)} = 0.02$, $p = 0.66$. Children were equally likely to select the vegetable that they had seen in their picture books and the control vegetable to taste first.

The next set of analyses explores the encouragement required to persuade children to eat the target and control foods (see **Table 3**). A Wilcoxon signed ranks test showed that significantly more encouragement was required to persuade children to taste the control vegetables than the target vegetables, $Z = -3.14$, $p = 0.001$. When the groups were split by initial status condition, children who were exposed to unfamiliar vegetables required more encouragement to taste the control vegetable than the target vegetable, $Z = -2.69$, $p = 0.007$. No significant differences was seen between the degree of encouragement required to persuade children in the liked ($Z = -1.32$, $p = 0.19$) or disliked ($Z = -1.38$, $p = 0.17$) conditions to taste the target and control vegetables, although the pattern was similar across the three groups. Thus, the experimenter found it easier to encourage children to taste the vegetable that they had seen in their picture-books, especially when children had not tried either food before.

Finally, we examined the amount of each food consumed by children (see **Table 3**). Overall, children consumed more of the target vegetable than of the control vegetable, $Z = -2.4$, $p = 0.016$. Again, while the pattern was broadly similar across the three groups, it was only the children in the unfamiliar initial status condition who consumed significantly more of the target vegetable (liked: $Z = -0.77$, $p = 0.44$; disliked: $Z = -0.95$; $p = 0.34$; unfamiliar: $Z = -2.5$, $p = 0.011$). The picture books therefore increased the amount of the target food consumed, particularly where the vegetable was unfamiliar at the start of the intervention.

To summarize, the results of the Parent Report Check confirmed that parents are able to report accurately on their child's likes and dislikes in relation to vegetables. Children were more willing to taste the vegetable that they were reported to like (as evidenced by the number of children who tasted the liked vs. disliked foods, the order in which these were tasted, and the level of encouragement required to persuade the child to eat them) and consumed more of the vegetable that they were reported to like.

The results of the Exposure Test were less systematic. First, whether a vegetable had been seen in a child's picture book did not influence whether it was tasted. This is perhaps not surprising given that children were repeatedly encouraged to taste both foods, but there was also no effect of exposure on the order in which children tasted the two foods. On their own, these findings suggest that the books did not affect children's willingness to taste the foods in them. Houston-Price et al. (2009b) similarly found no positive effects of exposure on either the frequency with which children tasted vegetables or the order in which they tasted them; in their study, the positive results pertained only to fruits. In both studies, the books' effects were sought in differences in children's behavior toward the target and control foods. While we expected control foods to provide a "baseline" measure of the child's willingness to consume a food of the same initial status as the target food, it is possible that reading the book could have affected the child's willingness to try other vegetables, in addition to the food targeted. This would, of course, have confounded the detection of differences in children's behavior toward the target and control foods at test. To explore this possibility, future studies should include a control group of children who do not see a book prior to testing, against whom the experimental group's eating behavior can be compared.

However, in contrast to our previous study, Experiment 2 found no negative effects of exposure to vegetables and, importantly, the additional measures collected in this study revealed some positive effects. Experimenter ratings indicated that less effort was needed to persuade children to taste target vegetables than control vegetables, particularly for foods that were unfamiliar to children prior to the study. The parallel behavior shown toward reportedly liked foods in the Parent Report Check gives us confidence in interpreting children's behavior toward target foods in terms of a greater willingness to taste these. The same pattern was seen in children's consumption of the target and control foods: children ate more of the target vegetable than of the control vegetable, and again this was particularly the case for foods that children had not tried previously. This was a rather surprising finding; while we had hypothesized that familiarity with the appearance of a food would increase children's willingness to try it, there was no reason to expect visual familiarity to enhance their liking of the food's taste. On the other hand, one might expect a similar pattern to be seen in measures of willingness to taste and amount consumed in this type of study, because a child who is willing to taste a food several times will necessarily eat more of it. If levels of food consumption are taken as an indication of food acceptance and food liking (Cooke and Wardle, 2005), this study provides the first evidence that picture books can be used to increase young children's vegetable intake. Moreover, the fact that infants ate more of the target vegetable on the very first occasion

the food was offered suggests that picture books might eliminate the need for repeated taste exposures when parents are attempting to introduce new vegetables into their child's diet.

GENERAL DISCUSSION

The experiments reported here corroborate previous reports that looking at picture books about fruits and vegetables increases infants' interest in looking at these foods (Experiment 1) and additionally demonstrate that such books can reduce the encouragement a child requires to taste a food and increase the amount of the food they consume (Experiment 2). Both studies confirmed that the impact of fruit and vegetable books depends upon the status of the food depicted, with the most positive effects seen for foods that were initially unfamiliar. Importantly, neither study found any negative effects of looking at books about foods, allaying fears raised by previous research that children might be less likely to taste familiar foods if these were repeatedly seen in picture books (Houston-Price et al., 2009b).

Houston-Price et al. (2009b) similarly reported more positive effects for foods that were initially unfamiliar to children. Fruit and vegetable books may therefore be most useful when a child is first introduced to a new food. Previous studies have shown that parents often fail to provide their child with sufficient taste exposures to a new food to bring about acceptance, due to the "bothersome behavior" children display when faced with new foods (Carruth and Skinner, 2000; Carruth et al., 2004). The current studies suggest that children might be more easily persuaded to try a new food and more accepting of its taste if they look at a book about the food before it is offered. Assuming that parents find repeatedly looking at a picture book about a food less stressful than repeatedly offering their child the food to eat, our findings suggest that picture books might help parents bypass some of the difficulties associated with introducing new vegetables.

While our two studies concurred in finding the strongest effects of exposure for initially unfamiliar foods, the visual preference data collected in Experiment 1 revealed a more graded effect of food status; the books had the least impact when they depicted foods that were already liked by the child and a moderate effect when disliked foods were shown. We are confident in interpreting these results in terms of genuine differences in the effectiveness of visual exposure to foods of differing initial status, for two reasons. First, children's behavior in the Parent Report Check of Experiment 2 unequivocally confirmed parents' ability to accurately report whether a vegetable was liked or disliked by their child. Across all measures, children were more willing to taste a vegetable that was reported to be "liked," and consumed more of this food, than of a vegetable that was reported to be "disliked." Second, in both experiments, the very existence of differences in children's behavior toward the foods in the differing initial status conditions confirms that the foods in each condition belonged to different categories for the child. That is, if parents had been unable to appropriately categorize foods as liked, disliked or unfamiliar, we would have seen no differences in children's behavior toward the foods in the different initial status conditions. In contrast, in both studies, children were affected differentially by the intervention depending on the food status condition to which they had been assigned. In relation to this point, it is worth noting that the failure to find an effect of exposure for liked foods in Experiment 2 was largely a consequence of children's willingness to consume both the target and control foods in this condition (see **Table 3**).

Interesting questions remain about the mechanisms by which picture books enhance children's interest in looking at and tasting the subject matter. As this type of intervention relies upon children spending time looking at the featured food, visual familiarity with the food is very likely to be central to its success. "Mere exposure" effects—whereby even very brief exposures to a stimulus can enhance participants' reports of how much they like the stimulus—have been demonstrated for a variety of types of visual stimuli, ranging from abstract shapes, such as Chinese characters (Monahan et al., 2000), to meaningful social stimuli, such as human faces (Zajonc, 1968, 2001). According to the "perceptual fluency" account of the mere exposure phenomenon, participants' positive attitudes toward exposed stimuli are attributable to the greater ease with which perceptual systems process stimuli that have previously been encountered (Bornstein and D'Agostino, 1994). The discovery of stronger exposure effects among the children who were shown exactly the same pictures of target foods that they had seen in their books in Experiment 1 suggests that perceptual fluency is likely to have been a factor in this study. By this view, the stronger exposure effects shown by children in the unfamiliar initial status condition would be due to the particular effort associated with forming a perceptual representation of the completely unfamiliar control foods, relative to the newly-familiarized target foods.

It is less clear, however, that perceptual fluency can account for children's behavior toward the target foods in Experiment 2, as these would have appeared perceptually quite different to the pictures children saw in their books. An interesting, alternative possibility is that the influence of the picture books arises through the foods' "learned safety" (Kalat and Rozin, 1973). The positive effects of repeated taste exposure on food liking (Birch and Marlin, 1982; Birch et al., 1987; Sullivan and Birch, 1990; Wardle et al., 2003a,b; Lakkakula et al., 2010) are often attributed to the child learning that a food is safe to eat as a result of a lack of negative consequences of consuming it. Zajonc (2001) argues that a similar mechanism accounts for mere exposure effects in other domains; repeated exposure to any stimulus without aversive consequence conditions us to learn that the stimulus is safe to approach. The implication of this claim is that our learning mechanisms do not distinguish between real world stimuli, which vary in how safe they are to approach, and pictorial stimuli, which do not. Children's greater willingness to taste the foods to which they had been visually exposed in Experiment 2 would, by this account, reflect the learned safety that resulted from exposure to pictures of the foods. The stronger exposure effect seen for unfamiliar foods would be explained in terms of children's complete uncertainty about the safety of the unfamiliar control food in this condition, in contrast to the control foods offered to children in the liked and disliked conditions, which would have been tasted, and discovered to be safe, before.

Visual familiarity is not the only factor likely to have contributed to the impact of the intervention on children's behaviors toward targeted foods, of course. Children could also have learned about foods through the verbal descriptions provided in the books, which included both neutral and positive statements.

Children are thought to organize their knowledge about foods in schemas, stored bodies of knowledge that facilitate the rapid processing and interpretation of information and determine how we respond to stimuli in future (Fiske and Taylor, 1991; Pliner, 2008; Vereijken et al., 2011). The changes we observed in children's behavior toward the target foods could reflect the assimilation of the positive statements children heard about the tastiness of the target food (e.g., "Carrots are great to eat raw because they are crunchy") into their schema for the food. The fact that picture books were most effective for unfamiliar foods, for which children would have held no pre-existing schema, suggests that it might be more challenging to adjust a pre-existing schema than to construct a positive schema for a new food from the outset. For liked foods, for which positive schemas are already held, there may be little scope for the information in picture books to enhance the status of the food. For disliked foods, the positive messages may be insufficient to overcome the child's stored memories of negative experiences with the food.

A further factor that might have contributed to the effects of the books is the manner in which they were delivered. Just as favorable experiences with foods lead to the development of positive schemas and expectations of liking of them (Pliner, 2008), the presumably enjoyable shared reading sessions with parents could support the development of positive expectations about the contents of the book. Anecdotal reports from the families who participated in these studies revealed that some parents attempted to make the book more enjoyable for their child by pretending to chop or eat the food shown. Previous research has shown that interactive reading styles are optimal for preschoolers' learning of the vocabulary contained in story books (see Mol et al., 2001, for a review); it is likely that such benefits extend to the learning of other aspects of a book's content. However, the nature of the interaction is likely to matter. One parent admitted adding the word "Yuk!" after reading every page of her child's book about mushrooms; unsurprisingly, the book did not have a positive effect for this child. Should picture books be recommended to parents as a way of introducing their toddler to a new food, we would encourage the parents who take up the opportunity to approach the process with a positive attitude.

It is important to highlight the role played by parents during the intervention, not only as readers of the book, but also as the providers of food for the family during the reading period. It is quite possible that the effects of our manipulation were driven by changes to the parents' attitudes and behaviors in relation to the target food, rather than, or in addition to, changes within the children. For example, reading a book about a little-known vegetable might increase the parent's interest in the food described and lead them to purchase or provide the food more frequently within the home. Although we have not tested this hypothesis, it is supported by anecdotal evidence from the families in our studies: one mother reported planting carrot seeds with her child after reading his book about carrots; another sent us photographs of a trip she and her child had made to a broccoli farm after reading a book about broccoli. Several parents reported that they had pointed out or bought their child's target food whilst in the supermarket. A more detailed investigation of the parental behaviors that accompany the sharing of picture books with children would help to establish the extent to which the positive outcomes of the intervention are a direct result of the books' influence on children's willingness to engage with the targeted foods vs. an indirect consequence of the books' influence on their parents.

There is therefore certainly more to learn about how picture books influence children's behaviors toward foods. Further work is also needed to establish how a picture-book intervention might be optimized. In neither the current studies nor in our previous work (Houston-Price et al., 2009a) have we found the number of exposures children receive to their book to determine the strength of the exposure effect; future studies should therefore seek to ascertain the minimum number of exposures required for a positive outcome. Work is also needed to optimize the content and style of the books for young children. The findings of previous research would suggest that the use of photographic images of foods should facilitate children in transferring what they learn from books to the foods they are offered at home (Ganea et al., 2008). However, some have found cartoon story books to have positive effects on eating behavior (de Droog et al., 2014) and, as yet, no study has directly compared these to the photo-style books used in the current studies. The books might also benefit from the inclusion of pictures of peers eating the target foods. Peer models are known to influence young children's eating habits (Birch, 1980) and are a key component of interventions to increase children's fruit and vegetable intake in nurseries and pre-schools (Lowe and Horne, 2009; Horne et al., 2011).

Our findings also hint at interesting new avenues for research into picture books, particularly their potential to bring about positive attitudes toward non-food stimuli. For example, book exposure might be used to familiarize children with creatures such as insects or spiders, which often promote unnecessary anxiety. Picture books might also be used for public health purposes; reading a toddler a book about teeth cleaning might increase the child's willingness to have their teeth cleaned. Effects might also translate to social stimuli; prior to a visit to an unfamiliar relative, a parent might show a child photographs of the person, to help the child feel comfortable about spending time with them. Thus, in addition to cultivating an enthusiasm for vegetables, picture books could prove to be a useful tool for supporting development more generally.

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SUPPLEMENTARY MATERIAL

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Learning mathematics in two dimensions: a review and look ahead at teaching and learning early childhood mathematics with children's literature

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In the past 25 years an identifiable interest in using children's literature in mathematics learning emerged (Clyne and Griffiths, 1991; Welchman-Tischler, 1992; Hong, 1996; Hellwig et al., 2000; Haury, 2001). We critically review the rationales given for the use of picture books in mathematics learning, with a special focus on geometry due to its underrepresentation in this body of literature and the need for greater focus on this topic. The benefits and effectiveness of using picture books for children's mathematics learning and interest have been documented (Hong, 1996; O'Neill et al., 2004; Young-Loveridge, 2004). For geometry, although much learning of shape ideas should be hands-on, two-dimensional figures are essential to develop children's understanding of plane geometry. Books may effectively engage pre-literate children with plane shapes (van den Heuvel-Panhuizen and van den Boogaard, 2008; Skoumpourdi and Mpakopoulou, 2011) and shapes as gestalt wholes or prototypes (van Hiele, 1986; Clements et al., 1999; Hannibal, 1999). We review several guidelines and evaluative criteria for book selection, including Cianciolo (2000), Schiro (1997), Hunsader (2004), and van den Heuvel-Panhuizen and Elia (2012). Geometry concepts have proven challenging for young students, but their difficulties may stem, in part, from inadequate teacher training and professional development (Clements and Sarama, 2000; Chard et al., 2008) which lead to misconceptions (Oberdorf and Taylor-Cox, 1999; Inan and Dogan-Temur, 2010). Using picture books in teacher training may be an inviting way for early childhood teachers to enhance their own knowledge. We will examine the literature for guidance on incorporating children's literature into teacher training. In closing we will outline a comprehensive, multi-pronged agenda for best instructional practices for selection and use of children's books in mathematics activities and for teacher training.

Keywords: picture books, children's literature, early childhood, mathematics, geometry, professional development

When children see a storybook or a picture book, they may not immediately associate it with mathematical ideas, but their teachers and scholars within the early childhood education and mathematics education communities have increasingly recognized the potential for using storybooks and picture books to aid in children's mathematics learning. However, the selection, evaluation processes, and implementations of these books for learning are not trivial processes and have become the subject of much writing and research.

Within this review we endeavor to shine light on the rationales and goals for using children's literature in mathematics learning and on the competing factors and viewpoints that influence this pursuit such as the push and pull between deep analysis and ease of use when evaluating books. Our review below begins with a brief chronology of literature on using children's literature in mathematics learning. Then we present the rationales for using children's literature in mathematics learning including developing the children's with regard to the National Council for Teachers of Mathematics (1989) mathematical processes, and their motivation and cognitive engagement. Throughout we identify and discuss the themes of scholarship of and advice for practicing teachers to choose and use children's literature effectively in mathematics. Through examples and within the section on rationales we devote a particular focus on using children's literature for geometry learning due to a significant gap in focus from both research and teacher professional development.

In the next section we address picture book evaluation processes for use in mathematics learning. In doing so, we especially attend to the selection of evaluation schemes relative to the purpose. We next present a review of professional development to support teachers' use of children's literature, with an eye toward early childhood geometry in particular. Lastly, we present recommendations for both research and practice, aimed at framing the research-practice cycle going forward.

For this review we refer first to van den Heuvel-Panhuizen and Elia's (2012) comment, "By "picturebooks," we mean books typically containing text and pictures in which pictures have an essential role in full communication and understanding (Nikolajeva and Scott, 2000). Arizpe and Styles (2003) stressed

that a picture book is a "book in which the story depends on the interaction between written text and image and where both have been created with a conscious esthetic intention" (p. 18). However, we note that other, broader, definitions may be considered, such as, "*mathematics literature* references any piece that has the potential to engage children in mathematical conversations" (Nesmith and Cooper, 2010, p. 280). As such, we would amend the definition to include wordless photography books or illustrated books, which may provide engaging, thought-provoking visuals for discussion and activities (e.g., Whitin and Wilde, 1995; Moyer, 2000). Additionally, even in the primary grades some books may be productive choices for engaging children with mathematical ideas even though they have few, if any pictures. While such variability in what may be considered children's literature for mathematics learning creates a complication for synthesizing across published works, using a broad definition of children's literature for mathematics learning reflects the topic as addressed today.

CHRONOLOGY OF CHILDREN'S LITERATURE IN MATHEMATICS LEARNING

Now a popular topic, the idea of using books as media for children's learning originated long ago: van den Heuvel-Panhuizen and Elia (2013) may have identified the genesis of the idea of young children learning through books, especially picture books, back to 1652 with Comenius' *Orbis Pictus*. However, while Comenius's idea provides an origin for using illustrated books for children's learning, concerted attention to their use for mathematics learning is a far more modern phenomenon.

Within more modern education literature, the topic of using children's book for mathematics learning began to emerge with initial direction toward the topic such as lists of suggested books from Beard (1962), Whitaker (1962), and Bravo (1965). None of these brief articles articulated the pedagogical processes in detail and for a couple of decades very little was written about this practice.

A notable departure from those works in text and symbol processing in mathematics learning came with Farr, 1979 article aimed at school librarians. She argued that with the adoption of socioconstructivist views of learning in primary grades, instruction needed to include both concrete hands-on experiences for mathematics learning and materials such children's books that could stimulate interactions. Unsurprisingly, given the lack of prior scholarly focus, she noted the dearth of appropriate trade books and found that those existing at the time often took a historical or instructional perspective and would not engage young learners. She called for books for mathematics learning that would be appealing, contain accurate information with precise use of any terms and clear presentation of concepts.

Such a well-reasoned call in a widely circulated school journal likely did contribute to the increase in trade books related to mathematical ideas for children, but much more remained to be delineated regarding the use of these books. In response to Farr (1979), Radebaugh (1981) offered lists of books for each of several early childhood mathematics topics, and a rationale for using books and suggestions for implementation. With these suggestions Radebaugh offered persuasive, practical advice such as using shape pictures in books as the basis for exploring hands-on shapes, although the work lacked evidence of the effectiveness of the practice of integrating children's books into mathematics learning. Likewise, Harsh (1987) delved into two popular children's picture books for their good fit with hands-on concrete activities to promote pre-number understandings but offered no empirical evidence of their effectiveness. Here and throughout this review, we recognize the value in practical advice for teachers, often from fellow teachers, but to propel the understanding of children's literature for mathematics learning forward, we also acknowledge the role of research to document relevant variables for successful implementation.

Since the early 1990s, a steady increase in the number of publications on the integration of children's literature into mathematics can be found (e.g., Clyne and Griffiths, 1991; Welchman-Tischler, 1992; Whitin, 1992; Haury, 2001), typically aimed at offering resources to teachers. This uptick of publications on the topic did not come out of the blue. As cited by Marston (2010) and van den Heuvel-Panhuizen (2012), the publication of the first Standards from the U.S. National Council of Teachers of Mathematics National Council for Teachers of Mathematics (1989) propelled interest in integrating children's literature into mathematics experiences. California, an influential force in U.S. educational practices with its large and diverse population, developed criteria for books to be included in the state mathematics program (Donoghue, 1996), and trade-book lists accompanied six of the 12 textbook series acceptable for adoption in California public schools. The book lists classified a book as acceptable for one or more of 12 mathematics topics common to the early grades. These events spurred the publication of trade books expressly intended for mathematics learning and of the study of such books and their implementation. Later *Standards* from the U.S. National Council of Teachers of Mathematics (2000) reinforced the use of children's literature for mathematics learning, but Marston characterized the resulting wave of new books as being of dubious literary quality. Thus, with such high-profile endorsements, the support for using children's literature for mathematics learning had spread but not necessarily in a consistent and high-quality manner.

Within those publications some have had the explicit goal of documenting how children's literature can have a positive outcome for mathematics learning (Jennings et al., 1992; Hong, 1996; Young-Loveridge, 2004) and provided evidence that the use of picture books in the early years of schooling can also contribute to the learning of mathematics. As the study of the topic has evolved, important aspects have been addressed, although each time prompting additional questions such as about the distinct contribution offered by the literature within the ongoing mathematics learning (Young-Loveridge, 2004) or the robustness of the results (Jennings et al., 1992). Some of this work will be discussed in greater detail below. Many of the publications about using children's literature in mathematics have been practitioner focused, presenting narratives from their classrooms of using literature for mathematics learning and/or presenting lesson activity examples and ideas, offering the realization of prior research or theory-based work.

Through its rise in popularity, the integration of children's literature with mathematics learning has grown to encompass many methodologies, foci and interest around the globe. The development of this topic has also been international, with the most prominent lines of scholarship coming from North America, Europe, and Australia. More recently, the study of the integration of children's literature into mathematics learning has included more rigorous scholarship, aimed at providing evidence of the efficacy of books in mathematics learning and teaching. Simply selecting and using a book with mathematics learning experiences, analogous to providing hands-on materials, does not guarantee learning. From the history of work on using children's literature for mathematics learning, we now examine this work more closely, focusing on the rationales for using the books and the evidence for their use.

RATIONALE FOR USING CHILDREN'S BOOKS

As the focus on children's literature as a resource and tool for mathematics learning became more prominent, authors identified additional rationales for using these books and functions of these books. Rather than borrowing one of the lists of reasons (e.g., Schiro, 1997) we recognize some overlap of rationales and purposes in which, for instance, while one article may name a rationale of nurturing children's positive dispositions toward mathematics, another cites the motivational potential of using picture books. Thus, we have codified the rationales into categories reflecting both emphases within the articles and their importance within standards and the larger body of literature.

Additionally, some of the rationales found in the extant literature encapsulate procedures such as to introduce manipulatives, to prepare students for a mathematics skill or concept (Price and Lennon, 2009) or to review a concept. Phrasing as such may imply a limited role for the book, not to provoke problem solving or analysis or deep engagement with the mathematics and the book. We will not review articles or elements of articles that focused on narrow procedural or functional aspects which an interested reader may find in practitioner-focused journals. Thus, rather than advice on procedural implementation, we focus here on deeper, more ambitious rationales for using children's books for mathematics learning. Even still, these rationales may overlap and are not mutually exclusive. For instance, making connections between a book's illustrations and hands-on experiences could also relate to the support children's representational understandings.

We first discuss each of the mathematical processes, socioemotional mechanisms, and the rationale and goal of reaching all learners that have been endorsed for using picture books. Then we pay particular attention to the use of children's literature to support young children's learning of basic geometric and spatial concepts.

Not all, and perhaps not many, articles addressing the integration of children's literature for mathematics learning have provided empirical evidence of the efficacy of this practice. Where authors have provided empirical evidence for effectiveness, we discuss that in turn and we identify the most significant gaps for additional empirical evidence to address in the following sections and in the closing section.

MATHEMATICAL PROCESSES

First, picture books could be seen as a means for developing young learners' understandings of the five mathematical processes standards of communication, representation, connections, problem solving, and reasoning and proof (National Council for Teachers of Mathematics, 1989). We also note below, where relevant, where these processes may overlap with the recent Mathematical Practices from the Common Core State Standards (National Governors Association Center for Best Practices, Council of Chief School Officers, 2010), currently being adopted in most of the United States.

COMMUNICATION

Taking a Vygotskian, sociocultural perspective, some authors have highlighted the social aspect of whole-class or small-group book reading as a site for interaction and sharing of ideas presented by or analyzed through the illustrations and text. Bringing shared literature in mathematics engages and socializes children into shared reading and learning; the books can also be a springboard for mathematical discourse between children and adults both at school and at home. Anderson et al. (2004, 2005) observed parent-child dyads in book readings and documented the shared mathematical discourse during the reading and parents' scaffolding of children's thinking. They presented fine-grained discourse analyses well, identifying how parents supported children's ideas, but they also stressed that story reading at home typically differs from book reading in classrooms. Their work raised important questions for how home-school connections could support literature for mathematics learning. Their work underscored the need for the educational community to offer support to families regarding book choices and perhaps also guidelines for at-home reading. We also note a potential particular needed for geometric concepts that may be less familiar than number-related concepts.

In the classroom, teachers can serve a facilitative role in the discourse around picture books, but Elia et al. (2010) and van den Heuvel-Panhuizen and van den Boogaard (2008) persuasively argued, with accompanying discourse analyses of children discussing the measurement and spatial concepts in books, that the children's self-initiated mathematics talk itself deserves study. The picture books they used engaged the children in reflection on mathematical concepts as evidenced by the children's spontaneous utterances during picture book reading. Here, again, not all books are equal in quality or fit for a group of students or a particular learning goal. These researchers, like Anderson et al. (2004), found that children's utterances differed in amount and kind including problem-solving statements based on the picture book used. However, looking forward, individual and situational variables must be considered to support learner's mathematics discourse.

Additionally, using children's literature has been deemed supportive of introducing vocabulary (Griffiths and Clyne, 1988; Doig, 1989; Welchman-Tischler, 1992; Charlesworth, 2005). However, the necessary characteristics of the books involved and the means by which this vocabulary development may be achieved have not been well explicated. Some good empirical evidence came from Jennings et al. (1992) intervention study in which children

in the literature-condition performed better on vocabulary assessments, as well as achievement and interest indices, following the 5 months intervention than children in the control kindergarten class. Their study is now over two decades old and more work is still needed to document how to support communication processes including mathematics vocabulary learning and mathematically rich discourse through experiences with story and picture books. Finally, with the outlining of the mathematical practices from the Common Core State Standards (National Governors Association Center for Best Practices, Council of Chief School Officers, 2010) future work should address how literature may aid young learners in going beyond simple communication to the third practice, "Construct viable arguments and critique the reasoning of others."

REPRESENTATION

Closely intertwined with mathematical communication, the process of representation stems from the natural connection between words and images. Focusing on this link, van Oers (2013) acknowledged the potential benefits of children's books for supporting discourse, especially when the discourse can be propelled by illustrations that support children's thinking about mathematical ideas.

Illustrations within picture books may be seen as representations of and for mathematical ideas for learners, to be recognized by them or scaffolded for recognition by their teachers, van den Heuvel-Panhuizen et al. (2009) asserted that, the text and illustrated representations may serve as cognitive hooks for young learners (Lovitt and Clarke, 1992) through the conduit provided from the book to other familiar experiences. The vignettes from their observations documented children's uptake of book illustrations as representations to engage in mathematical cognition. However, we must again remind readers of the caveat of *the potential* for a book or even only the *potential of some books,* and not inherent qualities for all books designated as for mathematics learning. Some books with intentional mathematical content have illustrations that are representationally poor in terms of the mathematical concepts, such as a shape labeled a square but with sides that are not straight lines or four sides but not all equal in length.

Additionally, even having attractive, engaging, mathematically relevant illustrations and representations is not enough. The correspondence between text and illustrations must be coherent. As Farr (1979) warned that discrepancies between a book's illustrations and the accompanying text can cause confusion, especially for the topics of time, distance, and spatial relations. Whether a book has text or is a book solely of photographs or illustrations, the mathematical concepts it purports to represent should be accurate representations of those concepts. Beyond accuracy, picture books' representations vary in their richness and presentation of exemplars. For example, a picture book may show triangles of various colors and sizes, but if they are all equilateral triangles, children experience a narrow representation of a triangle. In contrast, another picture book may include only a page or two with illustrations of triangles but include several scalene, isosceles, and right triangles as well as equilateral. Insufficient attention has been paid to the pictures within picture books as representations; many books may be pleasurable reading experiences but problematic for supporting learners' mathematical representations (e.g., Marston, 2010).

CONNECTIONS

Illustrated books may have a unique potential to promote young learners' connections between mathematical ideas and their experiences even out of school (Moyer, 2000). The union of text and pictures provided by books can support connection-making for learners at multiple levels as described by the National Council for Teachers of Mathematics (1989): among mathematical ideas and in contexts outsides of mathematics, to other content areas and to real-world or personal experiences (van den Heuvel-Panhuizen and Elia, 2012).

Often the text and pictures provide the topic, the anchor for mathematical discussions, from two-dimensional book pages to activities, typically with concrete representations (Anderson et al., 2004), and connections can bloom from there. From their classroom experiences, Shatzer (2008) and Hellwig et al. (2000), for example, highlighted the potential for well-selected literature to both support mathematical concept formation and bridge from the mathematical concept to students' lives. Connections may emerge spontaneously as students engage with a book individually or in a group, but when intentional, they must be authentic and supported. Hellwig et al. (2000) and Nesmith and Cooper (2010) pressed for connections to be meaningful and authentic to the children experiencing the books and for the connections to be as a web of interrelated ideas, rather than isolated. Given potentially significant differences by age, prior experience, and other learner characteristics, teachers, parents, and other stakeholders would benefit from more guidance for finding and using books that would connect meaningfully to a classroom or individual young learner.

PROBLEM SOLVING

Although a book reading activity can be its own engaging forum for mathematical thinking, books are frequently used as prior to hands-on activities, with the relevant concepts bridging the reading and hands-on activities. Skoumpourdi and Mpakopoulou (2011) offered good evidence and an effective rationale for using children's literature "to provide a model, illustrate a concept, pose a problem and stimulate an investigation" (p. 199), by using informal knowledge and experiences to connect to more formal mathematical problem solving.

Storytelling, engaging in narratives, in mathematics has been promoted by Zazkis and Liljedahl (2009), O'Neill et al. (2004), and Casey et al. (2004). This subset of work has outlined how engaging learners in storytelling can spark students' interest, engage them in mathematical cognition, reduce anxiety, and support the building of positive relationships between teachers and students and student peers. Story characters can be especially engaging means for posing problems (Casey et al., 2004; Skoumpourdi and Mpakopoulou, 2011) as children make sense of problem situations through the character's situation within the book, experiencing CCSS Mathematical Practice #1, "Make

sense of problems and persevere in solving them." Problem solving using picture books is also endorsed through a modeling approach, a vigorous line of research in mathematics education, can effectively include children's literature in modeling activities, to pose a problem, to provide information, to offer a context, to provide compelling characters in the posing of problems for modeling (English, 2010; Flevares and Schiff, 2013). For example, by following the actions of a dog named Baxter, students in English's study sorted and classified items and used them for data analysis in modeling a problem solution. The story offered an effective context for the children's problem solving.

REASONING AND PROOF

Lastly, the extant research and practitioner-focused articles on using literature for mathematics learning lack attention to the process of reasoning and proof. Only Marston et al. (2013) specifically addressed supporting students' reasoning, although others may have intended or assumed the process as embedded within problem solving activities. Marston, Muir and Livy discussed the implementation of a few picture books and how the books facilitated grade 1 and grade 2 children's engagement in concepts including through problem posing and generating and discussing multiple solutions. These activities entail reasoning, but yet, the process of reasoning could yet be more specifically addressed, particularly for the book's role in supporting the children's reasoning. Supporting children's reasoning from the givens within a book's text and with the representations on a two-dimension book page merits further study.

EMOTIONAL AND MOTIVATIONAL ASPECTS

Some of the attractiveness of using children's literature stems not from its support for content learning and cognitive engagement but their potential for children's social and emotional growth (Hong, 1996), encouraging the learners' persistence and goal-related, motivational behaviors (Ray and Smith, 2010). The motivational potential of children's books for engaging children in mathematics learning was also cited by Griffiths and Clyne (1991), Murphy (2000), Usnick and McCarthy (1998), and van den Heuvel-Panhuizen and van den Boogaard (2008), who noted how books can elicit emotional connections in learners, engaging them on multiple levels. One picture book often cited for learning primary grades shape concepts is *The Greedy Triangle* (Burns, 1994), which while presenting shapes in the plot, concludes with a moral of being happy with who you are. Well-selected books can successfully serve these multiple functions.

Hong (1996) cited the catalytic motivational property of children's literature for children's engagement with mathematics. Her own work provided evidence of storybooks' positive effects on children's dispositions toward mathematics learning as she documented students' increased preference for mathematics following the intervention with picture books. Thus, books may have the potential to offer an inviting, motivating context for mathematics learning. Experiences with picture books may spark children's curiosity, for instance, about fundamental geometric concepts as design and build with blocks in their classrooms.

REACHING ALL LEARNERS

Storybooks, if appropriately chosen, have the potential for supporting the mathematics learning of students of a wide range of learner characteristics including students with disabilities (Courtade et al., 2013) and students with low self-efficacy for learning mathematics (Jenner, 2002). Book reading may support positive cultural identity formation for students with regard to mathematics learning (Edelman, 2012), but care must be taken to select literature appropriate to a student population (Hefflin and Barksdale-Ladd, 2001), regardless of the academic content.

van den Heuvel-Panhuizen (2012) documented how interventions with picture book reading can be such broadly worthwhile and meaningful activities that they reach and support children of a wide range of background characteristics. She noted especially that picture books have been effective for supporting the learning of those with home languages different from those of the classroom or those from lower socioeconomic backgrounds and for girls. Casey et al. (2008) have documented gender-related effects of stories on mathematics learning, with regard to spatial concepts. Their hands-on intervention with stories engaged the children with puppets, chants, and movement. Based on their evidence, girls especially may benefit from an explicit, systematic approach to spatial reasoning experiences in classroom settings, making up the gap from what boys pick up otherwise. The numerous potential positive effects of using children's literature in mathematics learning await being more effectively harnessed as further delineation is needed identifying and guiding the selection and use of books.

CHILDREN'S LITERATURE FOR GEOMETRY LEARNING

As acknowledged by Clements et al. (1999) number-related topics dominate curricula and standards during early childhood and the primary and elementary grades. This predominance may have compromised the development of children's geometric and spatial concepts. The National Council of Teachers of Mathematics (2000) recommended a more equal balance between number concepts and geometry concepts, and for the United Kingdom, Jones and Mooney (2003) warned of the significant underrepresentation of geometry within the National Curriculum and the National Numeracy Strategy. We concur and argue that supporting learning of geometric concepts and spatial reasoning should be a priority moving forward for the study of children's literature in mathematics learning. Children's literature can play an important role in this mission and we now turn to examine the role of books in geometry concept learning especially.

Although less attention has been paid to story and picture books with geometric and spatial ideas than those with numerical topics, we argue that these books may be especially effective tools for these concepts. For geometry, although much learning of shape ideas should be hands-on, two-dimensional figures are essential to develop children's understanding of plane geometry. Books can effectively engage pre-literate children with plane shapes (van den Heuvel-Panhuizen and van den Boogaard, 2008; Skoumpourdi and Mpakopoulou, 2011) and shapes as gestalt wholes or prototypes (van Hiele, 1986; Clements et al., 1999; Hannibal, 1999).

Although Hannibal focused on shape learning and not particularly books for that shape learning, an important connection may be extracted: books can become grounds for presenting or reinforcing misconceptions about shape. She wrote that "perfect shapes are referred to as the best example or the prototypical triangle or rectangle that is most frequently presented in shape books, posters, puzzles, and toys. Therefore, for example, children would frequently not recognize a scalene triangle as a triangle because 'it is too crooked'" (p. 354). As of a result of incorrect, excessively narrow definitions and defining experiences, a child may develop a geometric misconception such that a square is not a rectangle by age five (Clements et al., 1999). Unfortunately, many picture books with shapes labeled may reinforce or encourage this misconception with different pages for "squares" and "rectangles," labeled as such, implying they are non-overlapping categories, and with no squares shown on the pages designated as "rectangles." Instead, high-quality literature could provide mathematically correct representations of shapes and related geometry concepts.

In both the vernacular and mathematical senses of the word, images within books can serve as "representations," and thus, picture books featuring shapes, whether illustrations or photographs, can be valuable stimuli for presenting basic geometric shapes in two-dimensional form. These two-dimensional representations can then be recognized and identified within the three-dimensional environment. The classroom teachers in Minetola et al. (2012) study conducted a geometry learning experience that fostered connections between shapes in their environment and items new to them, using Hoban's photography books, *Shapes, Shapes, Shapes* (Hoban, 1986), and *Cubes, Cones, Cylinders, and Spheres* (Hoban, 2000). The photographs within these books are not simple, isolated plane shapes, but rather shapes within visually complex photographs of people, places, and things. The authors focused well on connections and mechanisms for learning, noting that the children transferred their recognition of the two-dimensional shapes from the pictures to activities in their three-dimensional environment. Hands-on activities such as block building and tile designs are the three-dimensional tactile, haptic experiences with perception and depth. Paired with books representing shapes and spatial relationships, children can engage in seeing shapes in a two-dimensional plane and translating them to three-dimensional space, making conceptually meaningful connections.

Shape and spatial representations in books can provide provocative shared referents for small-group or large-group discourses when well implemented by teachers. From their research into the efficacy of using picture books, van den Heuvel-Panhuizen et al. (2009) provided powerful examples of visualization and discourse in the small-group discussions with the read-alouds by the teacher. These read-alouds and discussions promoted children's thinking regarding spatial relations in their familiar environment. The authors made a logical argument and provide good evidence for how experiences with books can thus support children's understanding of the geometric-spatial features of their familiar environment. To extend this work further, we can look to van den Heuvel-Panhuizen and Elia's (2012) framework for evaluating picture books. They distinguished three areas of geometry: orienting, regarding relative spatial sense; constructing, regarding composition in two- and three-dimensions; and operating with shapes and figures. These categories, in addition to basic shape recognition and shape attributes, will be productive for future studies of the research into learning experiences with picture books, including identifying books compatible with each of these categories for the breadth of geometry concepts. In the next section we explore their evaluation scheme and others for the features, including mathematical content evaluated for use in children's learning.

PICTURE BOOK EVALUATIONS

In this section we present and compare the criteria that have been developed for evaluating children's literature for mathematics learning. We highlight differences and commonalities in the criteria, foci and goals of the rubrics and recommendations. Later we discuss recommendations for applying these criteria to books and on the evaluation processes for teachers.

Educators should expect guidance from research on selecting and using children's literature in their mathematics teaching to find books that will both engage the young learners. The need for identifying and using only high-quality books cannot be overestimated (Whitin, 2002; Nesmith and Cooper, 2010). Rather than simply ineffectual, real dangers for learning may come from incorporating low-quality books in learning experiences. Didactically written "storybooks," which Nesmith and Cooper referred to as "pseudotextbooks," can be ineffective, unengaging, de-motivational, potentially harming students' interest in mathematics. A low-quality book used with the intent of mathematics learning may suggest or reinforce the mathematics is inherently uninteresting and requires a book accompaniment for engaging the children (Whitin, 2002), essentially presenting the book as a spoonful of sugar with the implied unpalatable medicine of mathematics.

To review the various book evaluation criteria, we looked for defined evaluation or selection criteria for systematic assessments of books for mathematics learning, as opposed to principles or more general guidance. Few sources met this criterion, as noted by van den Heuvel-Panhuizen and Elia (2012). We will focus on evaluation schemes devised or refined by Schiro (1997), Hellwig et al. (2000), Hunsader (2004), Nesmith and Cooper (2010), and finally van den Heuvel-Panhuizen and Elia (2012).

The formal efforts to evaluate children's literature for mathematics learning can largely be traced back to Schiro (1997) who created standards addressing both the mathematical and literary quality of books. He stated that began the process of creating literary and mathematical evaluation standards for excellence in 1990 with the aim of filling a perceived gap – no standards existed at the time. Schiro drafted exhaustive criteria, resulting in a 14-page evaluation instrument. In addition to the attributes of mathematical literary criticism he outlined, his mathematical standards included criteria for, mathematical accuracy, worthiness, visibility, appropriateness, involvement of the reader in the mathematics, the effectiveness of the presentation, the complementing of the mathematics and story, the availability of resources and mathematical information, the application of the content, and the view it presents of mathematics. Schiro's careful, comprehensive work moved the attention to

children's literature for mathematics learning significantly forward, but the instrument he created was so thorough, it was unwieldy for practitioners. His criteria might be amenable to an ongoing project by a group of teachers within a school building, and teachers may find the literary as well as mathematical emphasis appealing, but overwhelming for individual teachers.

Following Schiro's (1997) work, Hellwig et al. (2000) produced an instrument with five categories (accuracy, visual, and verbal appeal, connections, audience, and the "wow" factor), aimed at guiding teachers in effectively evaluating books. When applying these criteria to an evaluation, the authors warned that few books will score highly in all criteria, but that most books will have particular strengths highlighted by the instrument. Additionally, teachers are advised to keep in mind that the tool is a guide and should be used in conjunction with their judgment as professional educators. Such a tool may be best suited to teachers desiring a simple, global evaluation of a book, rather than a tool for more structured planning and decision making. While Hunsader (2004) lauded Hellwig et al. (2000) criteria for efficiency, she found their scheme lacking due to dropping Schiro's independent evaluation of mathematical and literary quality and his criteria for assessing both the mathematical and literary appropriateness of the book.

In her book evaluation scheme Hunsader (2004) aimed to achieve a middle ground, retaining some of Schiro's articulation but closer to Hellwig et al. (2000) efficiency. Recognizing its potential, Hunsader adapted Schiro's (1997) instrument from the more onerous 11-item-mathematical criteria and 11-item-literary criteria, to a more streamlined six categories, eliminating what she deemed redundancies. The six mathematics-related criteria included accuracy of math content, visibility of content and effectiveness of presentation, developmental appropriateness of math content, level to which the text facilitates the involvement of the reader, if the math content compliments the narrative, and how many resources would a teacher need to collect in order to use the text successfully. For the scoring on Hunsader's adapted model, five questions guided the evaluation of the literary quality of the book, regarding the plot's development, the writing style, the revelance of the illustrations, the developmental appropriateness, the coherence of the components of the book, and a sense of respect for the reader. Hunsader stated her criteria clearly and the rubric would be straightforward to implement. She used it to assess 77 books, each coming from one of two primary grades mathematics curricula and found many of the books rated too low to recommend for use in mathematics learning. However, her book evaluation process drew criticism.

Carrying Hunsader's (2004) work further, Nesmith and Cooper (2010) adopted her evaluation scheme with only a change in scoring. However, they noted the lack of clarity from Hunsader regarding how many reviewers scored books for her article, perhaps only Hunsader herself. They thus argued that the likelihood of multiple interpretations of books poses a challenge for the evaluation process. This may stem, at least in part, from fundamental differences in how mathematics concepts may be viewed within a book. As a result, they analyzed book evaluations from 30 reviewers representing mathematics professors, mathematics educators, English professors, literacy professors, and third-grade teachers. The group with the lowest agreement, while still acceptable, was the third-grade teachers. Unlike other respondents, they sometimes evaluated books given caveats for their implementation with a classroom. While this inclination may speak to the teachers' experience in the classroom and flexible planning, it but them less in sync with the other groups of raters, raising the question of whether it can be assumed that these groups share a common approach to book selection and use in mathematics learning, and if not, for what the potential mismatches in views imply for practice and research. Nesmith and Cooper could have developed or addressed this concern more directly; it remains a significant question.

Rather than conducting their own evaluations or soliciting only classroom teachers' reviews, van den Heuvel-Panhuizen and Elia (2012), like Nesmith and Cooper (2010), gathered and synthesized experts' opinions about the "powerful characteristics" of picture books for mathematics education. Using this Delphi method, to draw on seven experts' knowledge and opinions, their framework was revised and tested with three picture books. Also, notably, these researchers gave important consideration to the ideal relation between the text and illustrations in a book. van den Heuvel-Panhuizen and Elia (2012) recommended that text and illustrations should not be convey redundant information, arguing that this lack of redundancy is beneficial because, "the various and complex interactions between image and text (Nikolajeva and Scott, 2000) do not only enhance children's attention and engagement, but also help children discover different ways of connecting words and illustrations to construct meaning, and thus extend and develop their interpretive sophistication (Wolfenbarger and Sipe, 2007)" (p. 18). Such an emphasis on construction of the book and decoding by the readers differs notably from Schiro's (1997) emphasis on explicit mathematics being represented in words and pictures. Explicit presentations of mathematics in picture books may risk being perceived as pseudotextbooks (Nesmith and Cooper, 2010), and such books are well-represented among current tradebooks. As argued in the earlier sections on communication, representation, and connections, mathematical meanings can be recognized through the words and pictures and the experiences with them, even without explicit presentations of the mathematical concepts.

In the most recent evaluation scheme, van den Heuvel-Panhuizen and Elia (2012) drew upon the approaches mentioned previously to identify the learning-supportive characteristics of picture books for their use in supporting mathematics learning. It is clear from their results that the framework greatly assisted experts in recognizing the learning–supportive aspects of literature as compared to their recognition of such content without the use of the tool, but then the question remains of how it could be adopted by others, including teachers, more broadly. This dilemma brings us now to the processes of teacher education and professional development.

Each of the coding schemes offered a means of evaluating books to use in children's mathematics learning and they relied on various forms of expertise to evaluate the books. None of these studies compared the rated books in their implementation

with children individually or in classroom settings. Given the differences in emphases of the evaluation criteria and the different approaches to promoting learning with them, such as through teacher- or adult- scaffolded discourse, as opposed to using the books as springboards to a subsequent activity, comparisons of books and their implementations may be a greatly informative line of work.

TEACHER EDUCATION AND ONGOING TRAINING

Addressing the ongoing concern that students are not adequately prepared to engage in mathematically rich problem solving and discourse has been a concern of pre-service teacher preparation programs and in-service teacher professional development for some time now. We now address the role of children's literature in teachers' mathematics-related professional development. By looking specifically into geometric knowledge attainment of students and geometric content knowledge levels of teachers, which we again note has had significant gaps, we examine one component of mathematics as a whole and highlight the ways in which teachers can improve instruction and student outcomes. The primary concerns for professional development are the inadequate training and development available to teachers along with their use of limiting curricular materials, as this combination often results in the perpetuation of geometric misconceptions in their students (Clements and Sarama, 2000). Additionally, knowledge of individual children's developmental levels is also lacking, preventing teachers from providing instruction that is "consistent with their developmental process and individual differences" (Inan and Dogan-Temur, 2010, p. 457).

Chard et al. (2008) stated that student readiness to engage with mathematics concepts begins in infancy and must be supported through both informed, teacher-led instructional and repeated experiences with geometric content. Incorporating appropriate interventions during times of critical development of mathematical knowledge is a preventative strategy for supporting increased, accurate content knowledge in students. Likewise, Cotti and Schiro (2004) recommended that teachers identify their own ideological positions and how they influence their use of children's literature specifically during mathematics instruction. In order to reinforce their recommendation, they have created The Mathematics and Children's Literature Belief Inventory, which brings about deeper instructional awareness regarding "purposes, teaching, learning, knowledge, childhood, and evaluation" (p. 344). Awareness of these ideological beliefs also sparked discussion and reflection between teachers, which informed their practice. Identifying teacher's perceptions of their areas of growth provides a possible point of entry for exploring what effective professional development opportunities must encompass in order to meet the needs of individual teachers.

Learning experiences with children's literature are likely prone to confusion and errors as any other instructional means. Oberdorf and Taylor-Cox (1999) elucidated the ways in which some of the more common misconceptions are passed on to students through their identification of books containing such errors. They identified *The Silly Story of Goldie Locks and the Three Squares* (MacCarone, 1996) as an example of a book containing misconceptions due to the mismatch between the illustration and the text, as the shapes pictured are three solids yet they are named as two-dimensional shapes: circle, square, and triangle. Presenting such mismatches may seem trivial and easily corrected; however, the reality is that students retain these misconceptions as truths and experience confusion when trying to connect this knowledge to future learning. Without adequate experiences not only with the mathematical content, but also planning for learning with picture books, either in preparation programs or professional development teachers may not recognize such errors.

RESPONDING WITH PROFESSIONAL DEVELOPMENT

Effective instruction with children's literature must thus go beyond dissemination of theoretical guidelines and well-outlined narratives in practitioner focused journals to professional development for more profound change. Clements and Sarama (2011) outlined specific recommendations for accurately developing a teacher's knowledge of early geometric concepts. Professional development of this sort is intensive and focuses not only on teaching teachers how to increase student knowledge and outcomes, but also assesses and measures the growth of the teacher's knowledge. To begin broadly, "effective professional development ought to be extensive, ongoing, and reflective (p. 142)," meaning that schools must support teachers by providing development at multiple time points over the course of a year. During these sessions teachers are focused on specific geometric content knowledge aimed at connecting their knowledge to the understandings of their students (Ball et al., 2008). Teachers should be active participants in their development as they plan and create manipulative tools, engage in defining and discussing terminology, and examine the pedagogical implications for their students. Participation in high-quality professional development of this sort has successfully improved teachers' geometric content knowledge as assessed by their progression through the levels of van Hiele's (1999) model of geometric thinking.

As teachers strive to connect professional development to classroom practice, they often start by searching for supplemental materials that reinforce their newly attained knowledge. In the field of early childhood education, picture books are a familiar gateway for introducing purposeful, content-specific concepts to young children (Shatzer, 2008). When searching for such literature great care must be taken to evaluate the quality of the content when making these choices, as children's literature is too often inaccurate and laden with misinformation (Oberdorf and Taylor-Cox, 1999) or unengaging. Teacher professional development that incorporates practicing strategies for critically evaluating geometry based literature, materials, and student content knowledge will lead to richer classroom discussion and higher quality opportunities for student learning. Specifically, for recognizing shapes and their attributes, teachers can focus on gathering literature that presents geometric shapes in a variety of colors, sizes, and orientations while also presenting non-examples to deepen student discussion (Clements and Sarama, 2000). When teachers have experiences that promote their trust in and access to high-quality, accurate literature for use in their instruction, they can pay closer attention to preventing

future potential learning misconceptions in mathematics (Chard et al., 2008).

PROFESSIONAL DEVELOPMENT FOR INDIVIDUALS

More specifically, professional development opportunities should be created and teachers should seek out professional development that meets their individual learning needs while also translating the targeted instructional practices into their own instructional techniques. At times this may require teachers to seek out instruction or information on an individual level rather than in school-wide professional development. Teachers' efforts can be supported through the use of practitioner-based publications featuring titles like *Mathematizing Read-Alouds in Three Easy Steps* by Hintz and Smith (2013). The authors provided a way to connect math and storybooks through a three-step framework of choosing, exploring, and extending the text all in one short, peer-reviewed, accessible article. In addition to reading about instructional strategies, opportunities to read and review the content of children's books for their quality and connectedness to mathematical topics (LeSage, 2013) can be self-guided development.

Resources such as Shatzer's (2008) article *Picture Book Power* can be used by teachers to identify literature that has math content and organized it into specific math concepts for teachers while she also addressed how to use literature without specific math content. The author recommended that teachers focus on first leading students in enjoying the illustrations and text and then making connections to math content areas when reviewing the text. This type of modeled, purposeful instruction can ultimately become part of children's thinking as well as part of their own personal interaction with books. As teachers use articles such as the two mentioned above, they are developing themselves professionally while also making an immediate improvement to their teaching. However, teachers' independent professional development should be supplemental to efforts with others such as within a school or another teacher community. Collaborations among professionals can not only be effective, but may indeed be essential for developing effective planning and implementation of learning experiences with picture books, based on the strong evidence provided by Nesmith and Cooper (2010) and van den Heuvel-Panhuizen and Elia (2012).

PROFESSIONAL DEVELOPMENT WITH GROUPS

Individual professional development cannot meet all of a teacher's needs and may decide to seek the support of qualified instructors and or colleagues. One example that supports this thinking is the implementation of a structured set of lesson plans as outlined in the Early Learning in Mathematics Program (ELM) which increased both teachers' confidence in teaching geometric concepts and their students' geometric content knowledge over time (Chard et al., 2008). Picture books can then be incorporated as another source of geometric representations that need to be critically evaluated for their geometric content knowledge. As teachers deepen their pedagogical content knowledge for geometry, they will be better prepared to guide their students during discussions of the mathematics connected through texts.

A persistent challenge with short-term or limited professional development activities is the lack of support for continuing the implementation of the teachers' learning beyond the bounds of the professional development sessions. Recently, Brendefur et al. (2013) reported the positive impact 8 h of teacher professional development had on their classrooms' 4 year olds' mathematical knowledge. This professional development was structured to focus on the content of four mathematical domains, number, interpreting relationships, measurement, and spatial reasoning. Teachers who participated in this professional development took with them scripted lessons to enact as centers in their classrooms. Teachers could reference scripts as a way of seeking ongoing support after the conclusion of the professional development. Such a model could be implemented for the planning and implementation of integrating children's literature into mathematics learning, offering some reliable resources for implementing activities with picture books.

COACHING

The coaching model of professional development supports teachers through sustained one-on-one interaction during instructional times in the classroom and during group-centered initiatives led by coaches. Poglinco and Bach (2004) examined coaching over the course of 1 year finding that complexities within the relationship between teacher and coach can be unexpected. These relational aspects can have an impact on the effectiveness of the coaching model as a tool for delivering professional development. The authors also point out the strengths coaching brings when well-trained individuals are implementing the practice. According to Keller (2007) coaching meets the needs of teachers because it embraces the design of high-quality professional development as it is sustained over time, becomes part of a teachers' instruction, and promotes student achievement.

An example of the effectiveness of coaching is outlined by Rudd et al. (2009) as they investigated the language teachers use to supplement mathematical interactions in their research on teachers use of Math Mediated Language. Whole-group professional development was provided for teachers with the caveat that additional coaching in the classroom would be provided after the initial professional development intervention. Overall, the professional development had a positive effect on teachers' use of math language. However, teachers did not experience the increase until the onset of a coach in their classrooms, suggesting that perhaps follow-up coaching may be key to translating professional development into practice.

Poglinco and Bach (2004) warned that although coaching has been identified as an effective professional development model, teachers and schools must be informed as to the complexities before fully adopting the model. Considering the following aspects prior to implementing a coaching model are key according to Keller (2007): how it will be funded, how to define, select, and evaluate coaches, how principals and districts will support the coaches, and lastly the details of how often coaches will work with teachers in the schools. Regarding the use of picture books in particular, coaching can offer an ongoing relationship with the coach and potentially other teachers as well, to evaluate books

and then plan, implement, observe, assess, revise, and retry learning experiences with those books. Teachers can discuss with their coach and their peers which books contain accurate representations of shapes and descriptive text of those shapes, for instance, and which experiences with hands-on materials and the spatial environment of the classroom would be especially effective.

FUTURE DIRECTIONS AND RECOMMENDATIONS

RECOMMENDATIONS FOR TEACHERS

Whichever forms of preparation and professional development are implemented teachers must be well prepared to guide the children's *mathematics* learning through any instructional technique, including the use of children's literature. At least in the United States, primary grades and early childhood teachers often express a preference, interest in and greater comfort with reading and literature than mathematics, but to guide and scaffold students' mathematical discourse and interactions with materials including books and hands-on materials, teacher must have sound content knowledge in mathematics and pedagogical content knowledge for teaching mathematics.

As well prepared as any individual teacher may be, he or she could benefit greatly from well-structured, well-focused interactions with colleagues near or far. Creating collaboratives of teachers and other experts, as Nesmith and Cooper (2010) and van den Heuvel-Panhuizen and Elia (2012) did, may not be feasible on a large scale, but especially with the advent of social media and interactive web-based technologies, possibilities may now exist that did not when using children's literature first became popular. The use of these technologies can be a means of bringing educators together even across continents to share ideas for lessons and activities, to create collaboratives of book reviews, and to be a louder collective voice demanding publishers offer high-quality picture books, not boring, mathematically impoverished, or pseudotextbooks, for mathematics learning. The call for higher quality children's literature for mathematics learning harkens back to Schiro (1997) and yet many low quality books may be on school shelves, identified as mathematics resources, or on booklists for suggested choices for incorporating children's literature into mathematics learning experiences. When high-quality books have been identified, they should be shared through venues such as blogs, social media, and outreach projects to inform parents and others, not only of the existence of such high-quality literature appropriate for supporting children's mathematical thinking, but also suggestions for reading experiences with them.

RECOMMENDATIONS FOR RESEARCH

Almost two decades ago Hong (1996) called for more research into the use of picture books for children's learning and this need persists. The greatest need is for well-designed empirical studies to test the effectiveness of different book types (narrative and nonnarrative; those with text and those wordless books, etc.), different means of interacting with them (e.g., to promote mathematical discourse, to introduce a hands-on activity), different methods of implementation, and different models for linking to other mathematics experiences. Edelman (2012) offered a critique of the surge in work on using children's literature for mathematics learning and noted that many works are author testimonials or with the assumption that books will necessarily be effective for mathematics learning, rather than providing evidence for it. While practitioner-targeted guidance may support the ongoing use of books in mathematics learning, the research community must provoke issues such as characteristics of books and implementation to document the unique benefits or especially effective practices for using children's literature for mathematics learning. Unsupported claims about books' power must not be accepted and must not persist.

Ultimately, to continue to endorse the use of children's literature, positive impacts on teachers and children must be documented through multiple methods of investigation, including large-scale experiment-control studies, research with teachers, and fine-grained studies of individual learners. Important and high-quality work has been done on children's discourse during book reading (e.g., Anderson et al., 2004; van den Heuvel-Panhuizen and Elia, 2012), but significant questions remain such as measuring the children's cognitive engagement (McLaughlin et al., 2005; van den Heuvel-Panhuizen and van den Boogaard, 2008), classroom practices, implications of learner individual differences, and due to its importance and underrepresentation, the impact of children's literature on children's learning of fundamental geometry concepts.

CONCLUSION

Too often in materials for practitioners such as online resources for teachers, we see research-verified statements like "Literature can also relieve anxiety" (Whitin and Wilde, 1995, p. 9) but removed from the context, reasons, and implications that authors like Whitin and Wilde presented. For example, imagine an individual teacher coming across that statement regarding anxiety, but in isolation, and taking that statement at simple face value. Using read-aloud literature would not *necessarily* relieve anxiety for a child with hearing difficulties or children whose home language differed from the classroom. To aid teachers' implementation of learning mathematics, including geometry, with picture books, the larger communities of mathematics educators and early childhood educators must strive to shine light on and make widely visible the processes and choices with children's literature that can make it beneficial for student learning. In the absence of efforts on the part of not only individuals, but also the education community, children's literature may remain yet at its hypothesized, rather than realized potential.

It is remarkable how contemporary Farr's (1979) words sound even though they are decades old: she closed her article by saying, "We need more books based on concepts rather than abstract symbols, giving them direct application to reality and to the child's world. And, equally important, we need books to expand the world of mathematical ideas for children beyond those they will learn in school. Children must be exposed to the power and versatility, usefulness, and flexibility of modern mathematics through one of our most important forms of communication - the printed word" (p. 104). Researchers and educators have both the opportunity and responsibility to do so.

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Corrigendum: Learning mathematics in two dimensions: a review and look ahead at teaching and learning early childhood mathematics with children's literature

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Exploring story grammar structure in the book reading interactions of African American mothers and their preschool children: a pilot investigation

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The aim of this investigation was to identify the book reading behaviors and book reading styles of middle class African American mothers engaged in a shared book reading activity with their preschool children. To this end, the mothers and their children were videotaped reading one of three books, Julius, Grandfather and I, or Somewhere in Africa. Both maternal and child behaviors were coded for the frequency of occurrence of story grammar elements contained in their stories and maternal behaviors were also coded for their use of narrative eliciting strategies. In addition, mothers were queried about the quality and quantity of book reading/story telling interactions in the home environment. The results suggest that there is a great deal of individual variation in how mothers use the story grammar elements and narrative eliciting strategies to engage their children in a shared book reading activity. Findings are discussed in terms of suggestions for additional research and practical applications are offered on ways to optimally engage African American preschool children and African American families from diverse socioeconomic backgrounds in shared book reading interactions.

Keywords: African American mothers and children, book reading interactions, home reading environment, book reading styles, story grammar use and African American mothers

INTRODUCTION

For the past several decades, literacy researchers have turned their attention to exploring the ways in which mothers' structure and guide story telling interactions and shared book reading interactions with their children. As a consequence of this interest, a rich body of research has emerged identifying the different types of maternal conversational styles, book reading styles or story telling styles, and at some level correlating those styles with their children's immediate and long-term cognitive and literacy performances. This research has differed with respect to operationalization of maternal conversational styles and story-telling styles, and definition of narrative context. For example, Fivush and Fromhoff (1988) explored the conversational styles that mothers used to engage their children in a narrative context which involved conversations about the past. They observed that mothers employed either an elaborative conversational style or a repetitive conversational style. In the former style, mothers asked questions, re-casted statements, and provided fill in the blank details to their children's responses. In the latter style mothers mainly asked questions to elicit recall from their children and rarely varied their use of strategies. Children of mothers who employed an elaborate conversational style recalled more information about the past event in comparison to children whose mothers employed a repetitive conversational style.

Continuing along this line of research, and using a similar narrative context, Haden et al. (1997) found that maternal conversational styles fell into three distinct categories. The first category consisted of mothers classified as describers and these mothers used strategies that defined the past event, and strategies that elaborated on the past event. The second category was comprised of mothers who were identified as collaborators. They used strategies which encouraged their children to co-tell the event with them. Lastly, there were mothers who were classified as comprehenders. These mothers employed strategies that prompted their children to make connections with present experiences and past experiences. Haden et al. concluded that children of mothers who employed the latter two styles were more accurate in their recall of the past event in comparison to children whose mothers were classified as describers.

Other researchers have investigated maternal narrative styles or conversational styles as they emerged in the context of shared book reading activities with their children. Wellborn et al. (1999) identified two different maternal narrative styles in their study; story collaborators and story tellers. The story collaborators used strategies such as questions and prompt to engage their children in the book reading activity; whereas as the story tellers primarily used statements to engage their children in the book reading activity. According to Wellborn et al. (1999) children whose mothers used a story collaborative style were more involved in the interaction than were children whose mothers employed a story teller style. In a slightly similar study, Hammer et al. (2005) observed four distinct maternal narrative styles. There were mothers who were classified as text readers. Text readers read verbatim from the book without making requests to include their children in the reading activity. By contrast, some mothers were identified as labelers and these mothers read each word,

inserting pauses between each word, and similar to text readers made little effort to encourage their children to participate in the book reading activity. A few mothers were classified as child centered and these mothers allowed their children to assume control in the book reading interaction. Lastly Hammer et al. (2005) observed that some mothers used a combination style. In this case, they incorporated strategies reflective of the other three styles. Hammer et al. noted that children whose mothers used a child centered or combination narrative style were more involved in the book reading activity.

Using a fairly different method, Harris and Schroeder (2011) investigated maternal story telling styles as they occurred in the context of a constructive play activity. In this particular study, mothers were asked to tell their children a story about the objects/characters involved in the play activity and have their children re-tell the story to them. The researchers employing a story grammar schema to evaluate mothers' statements and strategies found that that their story telling styles and narrative eliciting styles cohered into two distinct categories. Thirty eight percent of the mothers used an inclusive story grammar style, and 62 percent used a restrictive story grammar style. Mothers using an inclusive story grammar style spent most of their time providing detailed instructions on the nature of the activity, providing detailed descriptions of the actions of the characters, and conversations between the characters; whereas mothers employing a restrictive story grammar style gave a brief overview of the goals of the activity, and spent most of their time discussing the location of the characters. Children of mothers, who employed the former narrative style were more engaged in the play activity as evidenced by their questions and comments during the interaction. With reference to narrative eliciting strategies, 16 percent of the mothers were identified as narrative scaffolders and 84 percent were identified as narrative solicitors. Narrative scaffolders elicited recall from their children by asking questions, using prompting statements, and providing corrective feedback to their children. In contrast, narrative solicitors spent most of their time eliciting recall about the story from their children through a series of prompting questions and provided little feedback to their children about their performance. Children of mothers identified as narrative scaffolders were able to retell more of the story about the play activity in comparison to children of mothers who were classified as narrative solicitors.

Collectively this corpus of research demonstrates that there is a great deal of variation in maternal narrative styles, and these styles differ to some extent depending on narrative context. Furthermore there is evidence to suggest that styles that invite children in the narrative activity appear to promote their active engagement.

In addition to examining maternal stylistic differences in narrative, play, and book reading activities, literacy researchers have also explored the quality of the book reading and literacy environment of the home. The comprehensive findings from this body of research suggests that literacy artifacts (books, newspapers), functional uses of literacy (reading), parental attitudes about literacy especially reading, occur with varying frequency in the homes of preschool children (Phillips and Lonigan, 2009). That is there are cultural and socioeconomic status differences with respect to the frequency with which parents provide their children with access to literacy artifacts, and engage in literacy related behaviors in the home environment with their children (Leseman and de Jong, 1998; Frijters et al., 2000; Burgess et al., 2002).

Only a few studies to date have looked at the conversational, book reading, or narrative styles of African American mothers engaged in a variety of narrative activities with their children. Those studies which do exist have focused mainly on low income African American mothers and their book reading interactions with their infants and toddlers (Pelligrini et al., 1999; Hammer et al., 2005). While these studies have provided literacy researchers with a wealth of information on the book reading behaviors and book reading styles of low income African American mothers, they yield little information on the book reading behaviors of middle class African American mothers. This is problematic for several reasons. First, the findings from the research on low income African American mothers are frequently generalized to account for the behaviors and practices of African American middle class mothers and as such researchers have an inaccurate and incomplete picture of the literacy practices and behaviors which occur in an economically diverse sample of African American mothers and their children. Second, as Heath (1983) and Tamis-LeMonda et al. (2008), state an area as critical as literacy should include explorations of a diverse array of cultural and economic groups; as culture broadly and narrowly defined plays a pivotal role in children's access to literacy materials, interactions with literacy materials, and subsequently their literacy performance in a formal academic setting. This gap in the literature serves as the major impetus for this present investigation.

This study is designed to address the following research questions.

Our first research question explores the book reading behavior of African American mothers engaged in a shared book reading activity with their children. We operationalize maternal book reading behavior in several ways. First, we examine their use of story grammar elements. Story grammar refers to the internal structure of simple stories or narratives. This internal structure frequently involves a beginning, settings, character descriptions, goals, actions, consequences, dialog, internal responses, and endings (Mandler and Johnson, 1977). Research indicates that stories which cohere to a formula that contains a beginning, middle, and ending are easily understood and recalled better by both adults and children (McCabe and Peterson, 1991). While books are traditionally designed to follow a story grammar structure, we are interested in determining the frequency with which mothers' emphasize those aspects of story grammar structure in their book reading behavior. Second, we examine their use of narrative eliciting strategies as they engage their children in the book reading activity. Narrative eliciting strategies as defined by Harris and Schroeder (2011) are questions, prompts, and statements employed by mothers to maintain and involve their children in the book reading activity.

Our second research question examines how preschool children participate in the book reading activity with their mothers. Our specific interest is to explore the story grammar elements

present in the preschoolers' vocalizations about the story. That is, do they use the same story grammar elements that mothers use? Researchers have found a correspondence between the verbalizations that mothers use in their narratives, and the verbalizations that children use as they re-tell stories (Haden et al., 1997).

Our third question investigates the quality of book reading-type activities available to the preschool children in their home environment. Using the Parental Support for Reading Activities in the Home Environment we queried mothers about their children's access to print, reading activities, and reading interactions in the home environment. We are also interested in determining the relationship between maternal book reading style and the quality of their home book reading environment.

In summary, the goal of this pilot project was to examine the book reading interactions of African American mothers and their preschool children. Mothers were observed engaged in a shared book reading activity with their preschool children, and a story grammar schema was used to identify their specific book reading strategies and book reading styles. We were also interested in determining the story grammar elements present in the preschoolers' verbalizations about the stories. In addition we asked mothers to respond to questions about the types of book reading interactions and activities available to their children in the home environment.

MATERIALS AND METHODS

PARTCIPANTS

Eight African American mothers and their preschool children recruited from childcare centers in a tri-county area participated in the study. Four of the children were males, and four were females. The children ranged in from 36 to 60 months ($M = 54$ month, $SD = 7.1$). The mothers on average were 30 years of age, married, and college educated. They were offered a payment of ten dollars for their participation in the research, and the children were offered a small toy.

STIMULI

Story books

Three story books were used as the stimuli in this present investigation: *Julius* (Johnson, 1993) which is a story about a young pig who lives with Mia and her parents; *Grandfather and I* (Buckely and Ormerod, 1994) is a story which focuses on the relationship between an African American grandfather and his grandson as they go about their daily activities; and *Somewhere in Africa* (Mennen and Daly, 1997) depicts the travels of a young boy as he journeys throughout Africa. The books for the most part are of equal length, contain the same narrative structure; all are illustrated and portray the lives of African or African American children and their families in central plot lines.

Parental Support for Reading Activities in the Home Environment Questionnaire is an 11 item questionnaire divided into two sections. The first section entitled, *Parental and Child Reading Interactions* contains questions that ask mothers to provide information on how frequently they engage in book reading activities in the home with their children. Examples of questions include: 1) How frequently do you read to you child? 2) How frequently does your child asked to be read to? 3) How frequently do you discuss reading material with their child? Answers to these questions were scored on a 5 point scale ranging from 5 (daily) to 1 (never). Additional questions asked mothers to provide information indicating whether their children had a regular reading time, at what age did they begin reading to their child, how frequently the child tries to read to them, to identity family members who read to the child, and how frequently is storytelling without a book a regular family activity?

The second section, *Support for Reading Activities in the Home Environment* is comprised of questions which probe mothers about the ways in which they provide support for reading related activities in the home environment. Examples include: (1) Does your child have any magazine or book subscriptions? (2) How many books are in your home? (3) Do you purchase games to help the child learn to read? (4) Does your child have a library card? (5) Does your child check out books from the library? Answers to these questions were coded yes or no.

Mothers were also asked to provide basic demographic information. Copies of the full questionnaire may be obtained from the investigators upon request.

Procedure

Upon arrival to the testing site, the mothers first completed the Parental Support for Reading Activities in the Home Environment Questionnaire. After completion of the questionnaire, the mothers were then videotaped reading one of three books to their children. The mothers were instructed by the researcher to read the books to their children in a way that they were comfortable with, there were no time constraints placed on the session and they were free to determine when to terminate the session.

Coding system

A modification of the Harris and Schroeder Story Grammar Coding System (2011) was used to code maternal and child story grammar elements and maternal narrative eliciting strategies. The videotapes were first transcribed and the transcripts were then coded by undergraduate psychology research assistants blind to the research questions of the study. The behaviors were coded for their frequency of occurrence.

Maternal (M) child (C) story grammar elements

Strategy	Description
Story beginnings (MSB/CSB)	Verbal indication that the story has begun
Settings (MST/CST)	Verbal references to the location, background, or time frame of the story
Naming/labeling (MNL/CNL)	Simple naming or labeling of the objects, characters in the story
Character descriptions(MCD/CCD)	Verbal references to the names, physical appearances and social roles of the characters in the book
Goals (MG/CG)	Verbal reference to the purpose, plans, intentions, wants, or desires of one or more of the characters in the book

(Continued)

Continued

Strategy	Description
Actions (MA/CA)	Verbal reference regarding a series of actions carried out by one or more of the characters in the book
Consequences (MC/CC)	Verbal references to direct consequence of an action carried out by one or more of the characters in the book
Dialog (MD/CD)	Verbal reference to conversation between characters in the form of quoted speech or implied dialog in the book
Internal responses(MIR/CIR)	Verbal reference to the inner thoughts or emotions of one or more of the characters in the book
Endings (ME/CE)	Verbal reference indicating that the story has ended

Maternal narrative eliciting strategies

Strategy	Description
Sequential questions (SQ)	Questions used to elicit the order of events in the story (e.g., what comes next, did this happen next?)
General question (GQ)	Questions used to elicit information about the names of the characters, character actions, feelings and relationships (e.g., who is this, what did Julius do? Where was Grandfather going? Where does Ashraf live?)
Re-focusing statements (RF)	Statements that refocus the child's attention to the story when the child strays off task (e.g., look at me)
Re-tells the story (RTS)	Statements that retell all or part of the story (e.g., let me tell my story again)
Re-casting (RC)	Statements that re-state the child's story or sentence to make it consistent with her story
Encourage (E)	Good job, you can do it
Fill in the blank statements (FIBS)	Statements that complete the child's story
Prompting statements (PS)	Statements such as did this happen, now can you tell me the story I just told you
Reference to memory (RFM)	Statements referring to the child's memory (e.g., can you remember what I just said? Come on you can remember it?)

RELIABILITY

Two raters independently coded 20 percent of the transcripts for reliability. Percentage of agreement was used as the reliability estimate and there was 90 percent reliability agreement among the raters for the strategies. Any disagreements were resolved through discussion. The remainder of the transcripts were divided and coded independently by the raters.

RESULTS

The results section begins with a discussion of the Parental Support for Reading Activities in the Home Environment, continues with a presentation of the descriptive statistics on the story grammar elements and narrative eliciting strategies present in the mothers' book reading and with a discussion of the story grammar elements present in the children's vocalizations about the stories. The section concludes with a discussion of maternal book reading styles.

PARENTAL SUPPORT FOR READING ACTIVITIES IN THE HOME ENVIRONMENT

Descriptive statistics for the home environment questionnaire are presented in **Table 1**. As the data in the table indicate, 83% of the mothers report reading to their children daily; and over half of the children frequently solicit requests to be read to from their mothers or from other family members. Fifty percent of the children have a regular reading time, over half of the mothers report they frequently engage in discussing reading materials with their children and the majority of the children have a favorite book. Over half of the children have books and or magazine subscriptions; and sixty-six percent of the mothers purchase specific material to help their children learn to read. The majority of the mothers report that their children have a library card and all report that their children check out books from the library.

STORY GRAMMAR ELEMENTS PRESENT IN MOTHERS' BOOK READING

Figure 1 provides information on the mean number of story grammar elements present in the mothers' book reading. As the figure shows, mothers used a variety of story grammar elements while reading the books to their children, however they placed special attention on discussing the actions of the characters ($M = 7$, $SD = 4.5$) and the dialog between characters, ($M = 2.3$, $SD = 1.9$), they mentioned the wants and desires of the characters in the story ($M = 2.1$, $SD = 3.6$), highlighted the settings of the story ($M = 1.87$, $SD = 1.64$), and stressed the social roles and the physical appearances of the characters in the book ($M = 1.37$, $SD = 0.74$).

NARRATIVE ELICITING STRATEGIES PRESENT IN MOTHERS' BOOK READING

Figure 2 presents the means on the narrative eliciting strategies used by mothers to engage their children in the book reading interaction. As the figure illustrates, while mothers used an assortment of narrative eliciting strategies, they most often employed refocusing statements to elicit engagement in the interaction from their children ($M = 6.3$, $SD = 7.65$), asked general questions about the characters in the story book ($M = 3.7$; $SD = 2.25$), and frequently encouraged their children's vocalizations during the book reading activity ($M = 1$, $SD = 1.19$).

PRESCHOOLER STORY GRAMMAR USE DURING THE BOOK READING ACTIVITY

Figure 3 depicts the means for the preschoolers' story grammar use during the book reading interaction. While they used considerably fewer story grammar elements than their mothers, they engaged in the book reading interaction by commenting on the

Table 1 | Parental support for reading activities in the home environment.

Questions	Percent
PARENTAL AND CHILD BOOK READING INTERACTIONS	
How frequently do you read to your child?	83% Daily
How frequently does your child asked to be read to?	83% Daily
How frequently do you engage in discussing reading material with your child?	83% Daily
Does your child have a favorite book?	83% Yes
Is there a regular reading time?	50% Yes 50% No
Does any other family member read to the child?	100% Yes
SUPPORT FOR BOOK READING ACTIVITIES IN THE HOME	
Does your child have a magazine/book subscription?	50% Yes
Do your purchase reading material?	66% Yes
Do you purchase reading games?	83% Yes
Does your child have a library card?	83% Yes
Does your child check out books from the library?	100% Yes

actions carried out by the characters ($M = 2.2$, $SD = 2.18$), generating the names of the characters of the book ($M = 1.6$, $SD = 1.99$), and remarking on the dialog or conversations occurring between the characters ($M = 1.3$, $SD = 1.9$).

MATERNAL BOOK READING STYLES

To determine maternal book reading styles a k-means cluster analysis was computed on the maternal story grammar frequencies and the maternal narrative eliciting strategies frequencies. Based on the findings from our previous research, we pre specified two clusters (Harris and Schroeder, 2011). The results of the k-mean cluster analysis for this study revealed that thirty eight percent of the mothers were in cluster one, and identified as employing a *modified text focused book* reading style and this style was characterized by an overall greater use of story grammar elements and narrative eliciting strategies. Sixty two percent of the mothers were in cluster two, and classified as using a *text engager* book reading style and characterized by using fewer story grammar elements and narrative eliciting strategies while reading the books to their children.

MODIFIED TEXT FOCUSED BOOK READING STYLE

We classified these mothers as employing a modified text focused book reading style for the following reasons. First, they adhered to a story grammar structure while reading. Second, they modified that structure to include narrative eliciting strategies. The following excerpt is an example of the pattern of interaction.

Story beginnings

Mother: This is called Grandfather and I. Sound interesting. Hmm. Grandfather and I are going for a walk. It will be a slow walk because Grandfather and I never hurry. We walk along and stop and look just as long as we like.

Child: Hurry, Hurry

Story settings

Mother: Ashraf lives in Africa, not Africa where lions laze in golden grass, not Africa where crocodiles glide through muddy rivers silent a hungry not Africa where Zebra's gallop over Great Plains, Asraf lives in a city at the very tip of the great African content.

Mother: Continues reading. In summer, the city lies soaked in African sun, dry under endless blue sky. Ashraf lives in the city. Where does Ashraf live?

Child: Points to page

Character actions

Mother: Turns the page umhmm, Hurry. But grandfather and I never hurry. Look (points at the page). We walk along and walk along. That could be a little Christmas tree. Father hurries off to work and hurry home again. Does your father hurry?

Child: Nods and says sometimes he does?

Refocusing statements

Mother: Look J look at the book. Julius made too much noise. Come on Sweetie.

Child: (Stops his attempts to get off the chair).

Mother: Look at the hats. Which one is red?

Child: (points to the hat and smiles). That one.

TEXT ENGAGER BOOK READING STYLE

We labeled these mothers as using a text engager book reading style for the following reasons. One, they used fewer story grammar elements in reading the book to their children and two, they began their reading with narrative eliciting strategies and continued to use these strategies throughout their reading. The example below illustrates the pattern of interaction between these mothers and their children.

They began their stories by naming the characters and continued the book reading activity by asking questions

Mother: It says somewhere in Africa. You see that? See the picture? He's got a book in his hand.

Child: Like us?

Mother: Mm Hm Begins to read the book.

Mother: (Stops, and asks) what's that right here?

Child: Airplane.

Mother: Good.... Continues reading. Not Africa where crocodiles glide through the muddy rivers. See them? The crocodiles?

Child: They came to eat the boy?

Mother: They are not going to eat the boy.

Child: Uh Huh!!

Mother: Continues Reading. Look at the Zebra's

Child: They run from somebody?

Mother: No.

Used Fill in the Blank Statements to Complete the Child's Story

Mother: Who is this? What is her name?

Child: I don't know. . . . . .

Mother: Mia and who might these people be?

Child: Father

Mother: Father and

Child: Mommy

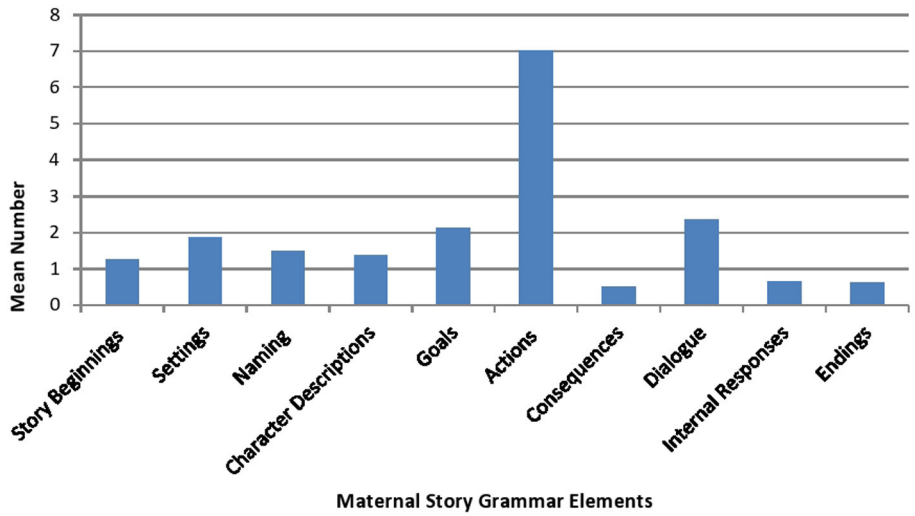

FIGURE 1 | Mean number of maternal story grammar elements.

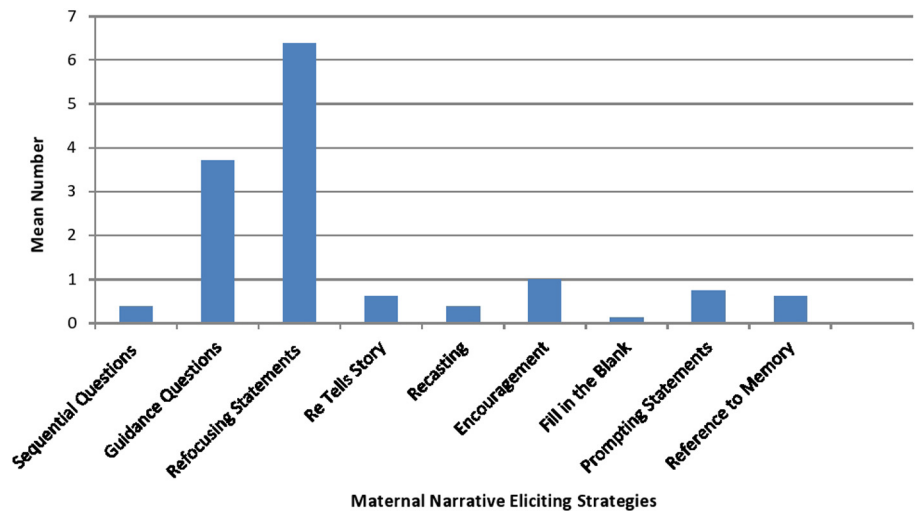

FIGURE 2 | Mean number of maternal narrative eliciting strategies.

Recasts the child's statements to be consistent with hers

Mother: Mia's parents did think they would like Julius. He showed them no fun and no sharing. Mia loved Julius. Why didn't Mia's parents like Julius?

Child: He's no fun?

Mother: He showed them no fun and no sharing.

We evaluated the Parental Support for Reading Activities in the Home Environment to determine if there might be differences in the home environments of modified text focused mothers and the text engager mothers. No significant differences were observed.

DISCUSSION

The general goal of this research was to explore the ways in which middle class African American mothers' structure and guide a book reading interaction for their preschool children. To accomplish this, we examined the presence of story grammar elements in their book reading, the types of narrative eliciting strategies they employed to maintain their children's attention during the book reading activity, and queried them about the quantity and quality of book reading activities and interactions available to their children in their home environment. In addition, we identified the types of story grammar elements present in the preschoolers vocalizations about the stories.

Our first finding suggests that middle class African American mothers use a variety of story grammar elements while reading books to their children. That is, they emphasize the actions of the characters, they engage in some form of character dialog, and they reference the goals of the story. To elicit contributions to the book reading interaction from their children, they employ refocusing statements, ask general questions, and encourage the

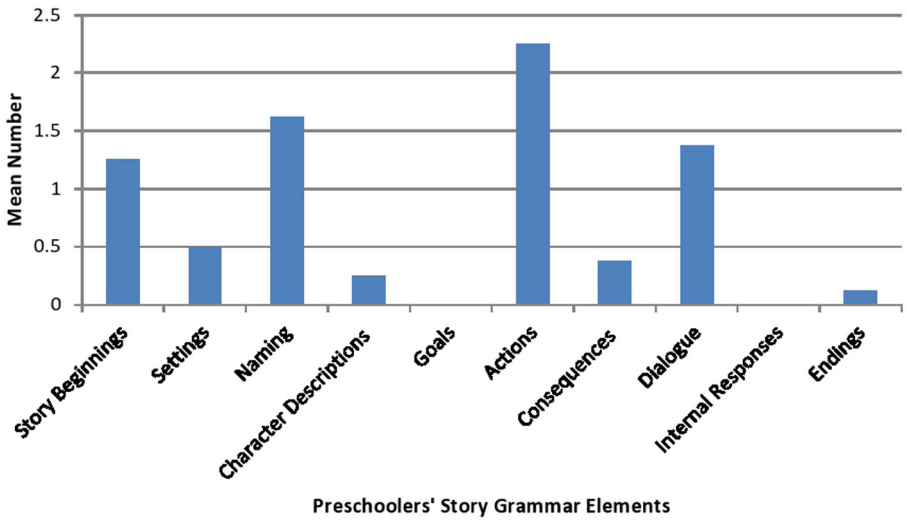

FIGURE 3 | Mean number of preschoolers' story grammar elements.

children's participation. The preschoolers, while they produce fewer vocalizations about the books than their mothers, similar to their mothers, commented on the actions of the characters and remarked on the dialog taking place between the characters.

Our second finding reveals that there are book reading styles that distinguish these mothers. A small percentage of the mothers in our study employed a modified text focused book reading style. In this instance, they began the story with an orientation indicating that the story had begun, and continued to focus on such salient aspects of the story such as setting, goals and descriptions of the actions of the characters in the story. While it is difficult to directly compare these styles to the styles other literacy researchers have observed; and that was not the intent of our research, we speculate that this style may be similar to the text reader style identified by Hammer et al. (2005). However, our mothers differ in that they rarely read directly from the book and they modified their reading to include strategies to re-engage their children in the reading activity. The majority of the mothers in our study used a text engager book reading style. They began their reading with questions to immediately capture their children's attention in the book reading activity. Their style may be reflective of what Heath (1983) refers to "using the book as a prop style." Books serve as a prop to facilitate interaction and perhaps an opportunity for the children to gain rudimentary knowledge of the mechanics involved in reading books. Their style also slightly resembles the child centered book reading style identified in the Hammer et al. (2005) research, but is somewhat different in that they did not surrender control of the book reading interaction to their children. They quickly launched into the activity, and employed a series of questions to capture and sustain the children's attention.

Our third finding suggests that African American children reared in middle class homes have print rich experiences and frequently engage in reading interactions and reading activities with their mothers and other family members. There were no differences in the home reading environments of children whose mothers employed the diverse book reading styles. It may be the case that home book reading environments are created to sustain and support the book literacy of all members of the families, as opposed to individual children. Furthermore it might be that differences in the home literacy environment emerge when children enter a formal academic setting.

Clearly there are limitations with our research. The small sample size limits the generalizability of our findings and as such the findings must be interpreted with some degree of caution. Thus any future research must consider increasing the sample size when addressing the following next steps.

There are several important next steps in this line of research. First, future research in this area must take into account the nature of the book reading materials. In contrast to the previous research on shared book reading and African American mothers and their children, we observed mothers reading books to their children consisting of African American characters and storylines. No studies to date have employed such a methodology. However, there is a current focus in U. S. preschool classrooms to introduce African American families to books that depict the lives of African American families and children. One notably example of this effort comes from the recent work of McNair (2014) who developed a family literacy program for an economically diverse group of African American parents and their children. The goals of the program were to introduce these families to books written about African American children, and to provide them with suggestions on ways to create a stimulating home reading environment. According to McNair, the follow up interviews with the parents revealed that many of them reported being unaware of books written with African American children and families as central characters; some stated that as a result of the program they increased their reading time with their children; several indicated that they were sharing their knowledge of African American children's books with other parents and a few reported purchasing additional books with African American

children and families as central characters. McNair concluded that in order for African American children to develop as successful readers it is important that African American children "see images" of themselves reflected in literature. Nyhout and O'Neil (2013) underscore this point and state that studies investigating shared book reading interactions "overlook the important role the book itself may play in the interaction and the role the book may play in the preschoolers' engagement in a shared book reading activity" (p. 2).

Subsequent research continuing along this line of study, could explore the influence of text content (i.e., books containing African American children and families as central characters vs. African American children and families absent from text) on maternal book reading strategies and book reading styles and the preschoolers' engagement in the book reading activity.

We also recommend that future investigations employ a microgenetic design (Siegler and Crowley, 1991). It may be the case that maternal book reading styles and strategies change along with book familiarity. In addition, there may be parallel changes which occur in the home book reading environment, that are best captured by a microgenetic design. Lastly, it is important to assess the children's contribution to the book reading interaction as their contribution and participation may change in tandem to maternal behavior.

In conclusion, the findings from this pilot study point toward the need for continued investigation into the book reading interactions of African American mothers and their children from diverse educational and income backgrounds. Based on this work, we have identified stylistic differences in their book reading behavior and captured at some level their children's engagement the book reading activity.

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Japanese mothers' utterances about agents and actions during joint picture-book reading

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This study extended the research on the scaffolding provided by mothers while reading picture books with their children from a focus on conversational styles related to labeling to a focus on those related to agents and actions to clarify the process by which language develops from the one-word to the syntactic stage. We clarified whether mothers decreased the degree of scaffolding in their initiation of conversations, in the responses to their children's utterances, and in the choice of referential ranges of their utterances. We also investigated whether maternal conversational styles contributed to the development of their children's vocabularies. Eighteen pairs of Japanese mothers and their children were longitudinally observed when the children were 20 and 27 months of age. The pairs were given a picture book depicting 24 animals engaged in everyday behavior. The mothers shifted their approach in the initiation of conversation from providing to requesting information as a function of their children's age. The proportion of maternal elaborative information-seeking responses was positively correlated with the size of their children's productive vocabulary. In terms of referential choices, mothers broadened the range of their references as their children aged. In terms of the contribution of maternal conversational styles to children's vocabulary development, the use of a maternal elaborative information-seeking style when the children were 20 months of age predicted the size of the children's productive vocabulary at 27 months. These results indicate that mothers decrease the degree of scaffolding by introducing more complex information into the conversations and transferring the role of actively producing information to their children by requesting information as their children develop. The results also indicate that these conversational styles promote the development of children's vocabularies during the transition from the one-word to the syntactic stage.

Keywords: scaffolding, referential choice, information seeking, elaboration, mother–child communication, toddlers, picture-book reading, Japanese

INTRODUCTION

During the second year of life, children experience remarkable linguistic development, rapidly increasing their vocabulary and beginning to produce word combinations. The role of hearing others' language in this development has been investigated, and picture-book reading is among the activities that have been suggested to promote children's language development (Fletcher and Reese, 2005). For example, Whitehurst and colleagues demonstrated the effects of dialogic reading on vocabulary development (Arnold and Whitehurst, 1994).

Speech by caregivers during joint picture-book reading has been shown to support children's language development. In this context, caregivers demonstrated greater lexical diversity, syntactical complexity, and more frequent topic-continuing responses (Hoff-Ginsberg, 1991) and focused more on labeling than they did in other situations (Tardif et al., 1999; Choi, 2000). Additionally, conversations between caregivers and children were characterized by attempts to attract the attention of the other party, requests for information, labeling, and feedback (Ninio and Bruner, 1978; DeLoache and DeMendoza, 1987).

Most studies of conversations between caregivers and toddlers have used picture books dominated by pictures of individual items (DeLoache and DeMendoza, 1987; Tardif et al., 1999; Murase et al., 2005; Chan et al., 2009) and have focused on conversations about object names. To date, few studies have analyzed more complex conversations between caregivers and toddlers that move beyond labeling. The bias favoring conversations about object names rests on the dominance of object names, especially among English-speaking children, during their first stage of vocabulary acquisition. However, they show a slow linear increase in their use of verbs and other predicates, with the greatest gains occurring when their vocabulary consists of 100–400 words (Bates et al., 1994). Japanese children share this tendency, although nouns are less predominant than among their English-speaking counterparts (Ogura, 1999). We need to extend our knowledge about mother–child conversations from a narrow focus on object names to a more expansive focus on utterances about the actions of agents. The present study used a picture book that included a series of scenes of an animal performing an action. We analyzed the utterances about agents and actions

offered by caregivers in the service of clarifying the process by which language develops from the single-word to the syntactic stage.

Bruner and colleagues proposed that caregivers provide language assistance to their children and mentioned scaffolding as one of the strategies employed in this process. Scaffolding consists of the structure provided by caregivers for those aspects of the task at hand that are beyond children's capacity (Wood et al., 1976; Bruner, 1981). They also identified raising the ante as another strategy in this domain. This strategy entails caregivers' efforts to find ways of challenging children to incorporate a task they have already mastered into a more complex routine for achieving a more remote end. As children grow older, caregivers reduce the degree of scaffolding and transfer the role to the children themselves with the expectation that the children will be autonomous participants in conversations (Wood et al., 1976; Bruner, 1981).

Wood et al. (1976) identified six processes involved in scaffolding: recruitment, reduction in degrees of freedom, direction maintenance, marking critical features, frustration control, and demonstration. We focus on reduction in degrees of freedom, direction maintenance, and demonstration in the present study. Reducing the degrees of freedom entails systematically simplifying the task by reducing the number of constituent acts required to reach a solution. Maintaining direction means that caregivers keep children focused on the pursuit of a particular goal. Demonstration involves the idealization by caregivers of the task in question, including completing or expanding on an action executed by their children, with the expectation that the children will then imitate the new version.

We investigated the scaffolding provided by caregivers in conversations before and after the performance of conversational elements by children. Our first research question relates to the degree to which caregivers provide scaffolding at the beginning of a conversation, before children produce utterances about agents and actions. From the perspective of scaffolding, caregivers' requests for information provide less scaffolding than does their provision of information. Requests for information provide children with a cue but not concrete information; this stands in contrast to the practice of providing concrete information in the form of a full model. In this regard, requesting information can be seen as requiring that the children control more degrees of freedom compared with providing information. Previous research has shown that as children increased in age, caregivers increased the frequency with which they initiated conversational episodes with requests for information (DeLoache and DeMendoza, 1987; Murase et al., 1998) and increased the frequency with which they requested information in general (Bornstein et al., 1992; Fernald and Morikawa, 1993). Unlike previous studies that investigated all requests for information, we differentiated caregivers' requests for information about agents from those for information about actions, and investigated whether caregivers initiated a larger proportion of both types of conversations by requesting information and a smaller proportion by providing information as a function of the increase in the children's age.

Our second research question related to the degree to which caregivers provided scaffolding in their responses after children provided information about agents and actions. Elaboration, which involves adding new information, can be seen as providing less scaffolding and raising the ante because it extends the children's utterances with the expectation that they will incorporate the new information into a more complex conversation. Previous studies have found that caregivers raise the ante in response to children's utterances as a function of children's age or linguistic ability and that maternal elaboration was more strongly related to children's linguistic ability than to their age (Ninio and Bruner, 1978; Murase et al., 2005). Thus, we hypothesized that the proportion of elaborative responses by caregivers would increase as children grew older.

In contrast, other-repetition involves repeating information provided by the other party in a dyadic interaction. Although other-repetition is used for various instructional and communication purposes, such as correction, acknowledging receipt of information, asking for clarification, and asking for confirmation (Demetras et al., 1986; Otomo, 2001; Huang, 2011), other-repetition can be interpreted as providing scaffolding. First, maternal other-repetition can serve as demonstration in the scaffolding process. Mothers may imitate children's attempts at information giving in an idealized form with the expectation that children will then imitate them. Second, maternal other-repetition can maintain the trajectory of the process. Mothers have the role of keeping younger children focused on the pursuit of a particular goal. In conversations, mothers may encourage children to continue a coherent dialog about a theme by explicitly repeating their children's utterances. Thus, we hypothesized that the proportion of other-repetition responses by caregivers would decrease as children grew older.

Additionally, we also investigated the extent of the information introduced by caregivers into conversations, the third aspect of scaffolding, which involves the issue of referential choice. Setting a limit on referential choices can act as a kind of scaffolding because caregivers reduce the degrees of freedom available to their children when referring to the scene.

Individuals in different cultures attend to different aspects of the same scene. Indeed, cross-cultural studies have found that East Asians are more attentive than are North Americans to contextual and relational information and that North Americans are more attentive than are East Asians to individual objects (Masuda and Nisbett, 2001; Masuda et al., 2008; Kuwabara et al., 2011; Kuwabara and Smith, 2012). Cross-linguistic studies of vocabulary development have revealed that Mandarin- and Korean-speaking children are less biased in favor of nouns than are English-speaking children and that Mandarin- and Korean-speaking caregivers use fewer nouns and more verbs in speaking to their children than do their English-speaking counterparts (Choi and Gopnik, 1995; Tardif, 1996; Tardif et al., 1997; Kim et al., 2000). A few studies have suggested that Japanese-speaking children are also less biased in favor of nouns than are English-speaking children (Ogura, 1999; Ogura et al., 2006). The results of these studies indicate that individuals choose the targets of their attention in a given scene, for example, an agent or action, in culturally specific ways.

Japanese is a pro-drop language, which allows the optional omission of either agent or object arguments (Guerriero et al.,

2006). For example Japanese allows, *Neko ga miruku o nondeiru* (A cat is drinking milk), *Miruku o nondeiru* (is drinking milk), *Neko ga nondeiru* (A cat is drinking), and *Nondeiru* (Drinking) for the expression of *A cat is drinking milk*. This means that Japanese speakers choose which elements to include in their description of a scene.

According to the foregoing discussion, Japanese caregivers make two kinds of choices about what to refer to in a scene: one involves the aspects to which they will attend, and the other involves the elements to which they will verbally refer. This study investigated how Japanese caregivers change their verbal referential choices in utterances directed at their children during joint picture-book reading. Previous studies about referential choice have focused on pragmatic explanations. For example, caregivers use more non-lexical than lexical forms in reference to given information (Guerriero et al., 2006), and they tend to mention unexpected more than usual objects (Sethuraman and Smith, 2010). However, changes in the range of references by caregivers have not been clarified.

Working from the perspectives of scaffolding and raising the ante, we hypothesized that caregivers would narrow their references to specific elements within a scene when communicating with younger children, whereas they would broaden this range as children got older. Specifically, we predicted that caregivers would refer only to the agents or the actions in a scene more frequently when communicating with younger than with older children. In contrast, we predicted that caregivers would refer to both the agents and the actions in a scene more frequently when communicating with older than with younger children.

As this study used a longitudinal design, our fourth research question addressed the effects of maternal conversational style on children's vocabulary development. Previous studies have found that maternal responsiveness (Tamis-LeMonda et al., 2001; Tamis-LeMonda and Bornstein, 2002) and maternal lexical richness (Bornstein et al., 1998; Hoff and Naigles, 2002) had positive effects on children's vocabulary development. The present study investigated the effects of the styles used by mothers to initiate conversations about agents and actions, their approaches to responding to children's information-giving utterances about agents and actions, and the effects of their referential choices about information about agents and actions on their children's vocabulary development.

In summary, this study investigated four issues. First, we clarified the degree of scaffolding provided by caregivers when initiating conversations with their children by providing or requesting information about agents and actions. We hypothesized that the proportion of conversations initiated by caregivers about both agents and actions by providing information would decrease and the proportion initiated by seeking information would increase as the children's age increased (hypothesis 1). Second, we determined the degree of scaffolding provided by caregivers in their responses to their children's provision of information about agents and actions. We hypothesized that in response to information provided by their children caregivers would engage in more elaboration and less other-repetition as the age of their children increased (hypothesis 2). Third, we clarified changes in caregivers' referential choices. We hypothesized that caregivers reduce references to agents or actions alone and increase references to both agents and actions as children age (hypothesis 3). Fourth, we investigated the effects of maternal conversational styles at an earlier time on the size of children's productive vocabulary at a later time, controlling for children's productive vocabulary size at the earlier time.

MATERIALS AND METHODS

PARTICIPANTS

Eighteen pairs of Japanese mothers and their children (8 boys and 10 girls) were observed when the children were 20 (range: 20.0–20.13, mean: 20.05) and 27 (range: 26.29–27.17, mean: 27.08) months of age. Based on the norms of the Japanese MacArthur Communicative Development Inventory (JCDI), which show that the median size of the productive vocabulary size of 20-month-old boys is 63 and that that of 20-month-old girls is 95, we studied children of this age because they have a substantial productive vocabulary (Watamaki and Ogura, 2004). Moreover, Japanese children exhibit a growth spurt in the size of their vocabulary at an average of 20 months of age (Kobayashi et al., 2013). We considered 27-month-old children to be in the syntactic stage based on data about maximum sentence length and the age at which they begin to combine words. According to JCDI norms (Watamaki and Ogura, 2004), more than 90% of 27-month-old Japanese children had started to combine words, and the median maximum sentence length was 4.27 words among 27-month-old boys and 5.78 words among 27-month-old girls. Seven children were first born, seven were second born, and four were born third or later in their families. Fourteen children were cared for by their mothers at home, and four children were cared for at day nurseries during the day.

PROCEDURE

Each mother–child pair visited the playroom of the university when the child was 20 and 27 months of age. The book-reading session lasted 7 min to enable the young children to maintain their attention on the book. The experimenter left the room during the reading and then returned and stopped the session after 7 min even if the participants had not finished looking at all the pictures to minimize the children's frustration. As this study is a part of a project examining mother–child interaction, a 7-min play session simulating a dressing situation preceded and another 7-min play session simulating a cooking situation followed the book-reading session. The mothers also completed questionnaires regarding their children's productive vocabulary. When their children were 20 months of age, these questionnaires addressed whether and how their children produced a word for 82 familiar items and whether and how their children produced a word in 62 situations. The 82 familiar items included animals (e.g., dog), foods and beverages (e.g., banana), clothing (e.g., shirt), small household items (e.g., spoon), and places (e.g., bathroom). The 62 situations included interactions (e.g., giving something to a family member), requests (e.g., asking to be picked up), routine events (e.g., getting up in the morning), experiences (e.g., eating a favorite food), and actions (e.g., sitting on a chair). When their children were 27 months of age, the questionnaires asked the questions about 112 familiar items and 76 situations. The 112 familiar items

included the 82 used at 20 months as well as several additional items (e.g., pigeon, pineapple). The 76 situations included the 62 used at 20 months as well as several additional situations (e.g., asking about why certain actions were taken and correcting the verbal expressions of others). These instruments were used to assess the size of the children's productive vocabulary. We assessed children's productive vocabulary size by counting the different word types reported by mothers in response to both familiar items and situations.

MATERIALS AND CODING

Materials

Each pair received a wordless picture book created for this research that depicted 24 animals engaged in ordinary behaviors (e.g., a horse eating bread, a lion playing with blocks; **Figure 1**).

Utterances for analysis

We analyzed utterances during episodes in which the mother and child jointly looked at the picture book. We defined episodes in reference to the reading cycle (Ninio and Bruner, 1978). The onset of an episode was recorded when (a) the book was open to a picture within 50 cm from both the child and mother and (b) the child or mother was pointing, gesturing, or vocalizing in some fashion that was directed to the content of the book. The offset of an episode was recorded when any of the following occurred: (a) the book was closed, (b) a new picture was introduced, or (c) either the child's or the mother's attention was withdrawn from the picture for more than 5 s. An utterance was defined as an informational unit that conveyed an idea. We divided speech into utterances based on syntactical information and supplemented this with observations of pauses and prosodic information when necessary to identify the endpoints of utterances.

Coding of individual utterances by mothers

Utterances including the names of animals appearing in a picture in the book were coded as instances of giving information about agents. We included not only conventional naming using nouns but also conventional onomatopoeias in this category because onomatopoeias are often used as labels for animals during conversations between Japanese mothers and children (e.g., *wanwan* [woof-woof] and *inu* [dog] were both coded as giving information about agents). Utterances with information about the actions performed by the animals in a picture were coded as giving information about actions. We included not only conventional verbs but also conventional onomatopoeias in this category because onomatopoeias are also often used to express actions in conversations between Japanese mothers and children (e.g., both *gokungokun* [onomatopoeia for drinking] and *nonderu* [drinking] were coded as giving information about actions).

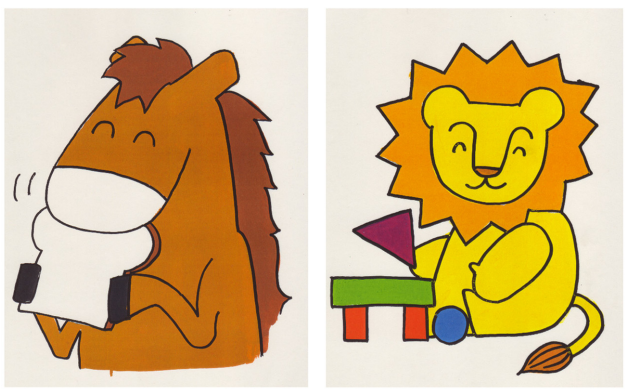

FIGURE 1 | Examples of pictures used.

Utterances requesting the names of animals appearing in a picture in the book were coded as seeking information about agents (e.g., *Kore dare?* [Who is he?]). Utterances requesting information about actions depicted in a picture were coded as seeking information about actions (e.g., *Nani shiteru?* [What is he doing?]). Ambiguous utterances requesting information (e.g., *Kore wa?* [And this?]) were excluded from both categories.

The above categories were multiply coded. For example, statements by mothers such as *An elephant is washing his body* were coded as providing information about agents and actions, and utterances such as *What is the lion doing?* were coded as requests for information about actions and providing information about agents.

Coding of individual utterances by children

Utterances in which children provided information about agents and actions were coded using the same criteria as those used for mothers. Information requests issued by children were not differentiated according to whether their focus was on agents or on actions.

Coding of conversation initiation

The style of initiating conversations about agents and actions in response to each picture was coded in terms of three categories: maternal initiation by information giving, maternal initiation by information seeking, and children's initiation. In terms of information about agents, maternal initiation by information giving was coded when mothers initiated a conversation about agents with information giving preceding information seeking (e.g., mother said, "*He is a dog*," and then child said, "*Dog*"). Maternal initiation by information seeking was coded when mothers initiated a conversation about agents with information seeking preceding information giving (e.g., mother said, "*Who is he? He is a dog*," and then the child said, "*Dog.*"). Children's initiation was coded when children initiated a conversation about agents by information giving or information seeking (e.g., the child said, "*Dog*," and then mother said, "*Yes, he is a dog*"). We coded data on the initiation of conversations about actions in the same way as we coded data on the initiation of conversations about agents.

Coding of mothers' responses to children's provision of information

Mothers' utterances in the first and second turns following utterances in which children provided information about agents and actions were coded as "elaborative information giving," "elaborative information seeking," or "other-repetition." We defined elaboration as adding new information during conversations.

Recent studies have shown that different styles of elaboration should be differentiated from one another (Fivush et al., 2006; Melzi et al., 2011), and we distinguished two types of elaboration: giving and seeking elaborative information. Both types can be viewed as ways to raise the ante as they introduce more complex information into conversations. However, requesting elaborative information provides less scaffolding than does offering elaborative information because the former involves questions rather than the provision of concrete information. Elaborative information giving was defined as the provision of information that had not been produced by the children during the episode in question. For example, a code of elaborative information giving was given when a mother said, "*He is washing his body*" in response to her child's saying, "*Elephant*," but this code was not given when a mother responded to the same utterance with, "*He is an elephant.*" Elaborative information seeking was defined as a request for information that had not been previously produced by the children during the episode in question. For example, a code of elaborative information seeking was given when a mother asked, "*What is he doing?*" following a child's saying, "*Elephant.*" Other-repetition was defined as information provided by mothers that repeated the information provided by children in the last turn. For example, a code of other-repetition was given when a mother said, "*He is a lion*" after her child said, "*Lion*," but this code was not given when a mother said, "*He is an animal*" following her child's utterance of "*Lion.*" These three categories were multiply coded. For example, codes of other-repetition and elaborative information giving were given when a mother said, "*The elephant is washing his body*" after her child said, "*Elephant*" because the utterance both repeated information provided by the child and offered new information.

Inter-coder reliability

Two coders independently coded all utterances. The *kappa* values representing the reliability of maternal information giving about agents and actions and maternal requests for information about agents and actions were 0.98, 0.89, 0.91, and 0.95, respectively. The *kappa* values for children's information giving about agents and actions and for children's requests for information were 0.97, 0.87, and 0.84, respectively. Final coding was determined by discussions between the two coders.

ASSESSMENT OF CHILDREN'S PRODUCTIVE VOCABULARY

We assessed the children's productive vocabulary at 20 and 27 months of age according to two criteria. The first criterion was the number of different word types produced by the children during a 7-min book-reading session and two 7-min play sessions. The second criterion was the number of different word types reported by mothers on the questionnaires. The two criteria were strongly correlated [$r(16) = 0.80$ at 20 months, $r(16) = 0.83$ at 27 months], and children showed stability in their word productivity. The productive vocabulary sizes estimated via observations of the 21-min sessions conducted at 20 and 27 months of age were strongly correlated [$r(16) = 0.74$], and the productive vocabulary sizes estimated by mothers at these two stages were also strongly correlated [$r(16) = 0.88$].

RESULTS

The mean numbers of pictures referenced by mothers and children and the mean numbers of utterances by mothers and children per picture are presented in **Table 1**. A repeated-measures ANOVA on the number of pictures referenced by mothers and children revealed a main effect of children's age. More pictures were referenced by mothers and children when the children were 27 months of age than when they were younger, $F(1,17) = 8.35$, $p < 0.05$, $\eta^2 = 0.33$. The numbers of pictures referenced when children were 20 and 27 months were consistent [$r(16) = 0.56$, $p < 0.05$].

Repeated-measures ANOVAs on the number of utterances by mothers and by children per picture revealed a main effect of children's age on children's utterances, $F(1,17) = 18.41$, $p < 0.001$, $\eta^2 = 0.84$, and a marginal main effect of children's age on maternal utterances, $F(1,17) = 3.09$, $p < 0.10$, $\eta^2 = 0.15$. Both mothers and children increased the number of utterances per picture as children developed from 20 to 27 months. The number of maternal [$r(16) = 0.41$, $p < 0.10$] and child [$r(16) = 0.44$, $p < 0.10$) utterances per pictures were moderately consistent between 20 and 27 months of age.

INITIATION OF CONVERSATIONS BETWEEN MOTHERS AND CHILDREN (HYPOTHESIS 1)

The following analysis examines the results of the repeated-measures ANCOVAs treating children's age as an independent variable and children's observed productive vocabulary size at 20 months as a covariate. We also treated the productive vocabulary size reported by mothers at 20 months as a covariate. When the second analysis produced essentially the same results as the first, we do not report the second analysis. When the second analysis produced results that differed from the first, we report the second results after the first.

The three ways of initiating conversations (maternal information giving, maternal information seeking, and children's initiation) were analyzed separately for the conversation for both agents and actions. Comparisons were calculated by dividing the number of pictures in response to which mothers and children initiated a conversation about agents (actions) in each of these ways by the total number of pictures in response to which mothers and children referred to agents (actions). **Table 2** presents the mean proportions of the three styles of initiating conversations about agents and actions.

In terms of the initiation of conversations about agents, a series of ANCOVAs revealed main effects of children's age on the proportion of utterances in which mothers provided information

Table 1 | Mean numbers of pictures referenced and mean number of utterances per picture (SDs in parentheses).

	20 Months	27 Months
Number of pictures referenced by mothers and children	17.22 (5.12)	20.11 (2.74)
Number of utterances per picture by mothers	4.95 (2.51)	5.98 (1.96)
Number of utterances per picture by children	1.75 (1.62)	3.27 (1.07)

Table 2 | Mean proportions of initiation types (SDs in parentheses).

	20 Months	27 Months
Initiation of conversation about agents		
Maternal information giving	0.43 (0.27)	0.21 (0.21)
Maternal information seeking	0.52 (0.28)	0.58 (0.27)
Children's initiation	0.05 (0.12)	0.20 (0.21)
Initiation of conversation about actions		
Maternal information giving	0.78 (0.17)	0.43 (0.22)
Maternal information seeking	0.22 (0.16)	0.50 (0.20)
Children's initiation	0.01 (0.03)	0.08 (0.12)

and children initiated conversations, $F(1,16) = 7.38$, $p < 0.05$, $\eta^2 = 0.32$; $F(1,16) = 8.95$, $p < 0.01$, $\eta^2 = 0.36$, but no main effect of children's age on the proportion of maternal information-seeking utterances was observed. As the children grew older, the mothers initiated a smaller proportion of the conversations by providing information, and the children initiated a larger proportion of the conversations.

In terms of the initiation of conversations about actions, a series of ANCOVAs showed main effects of children's age on the proportion of maternal information-giving and maternal information-seeking utterances, $F(1,16) = 16.76$, $p < 0.001$, $\eta^2 = 0.51$; $F(1,16) = 14.88$, $p < 0.001$, $\eta^2 = 0.48$, but no main effect of children's age on the proportion of conversations initiated by children was observed. Mothers initiated a smaller proportion of conversations about actions by information giving and initiated a larger proportion by information seeking as their children aged from 20 to 27 months.

When we used the productive vocabulary size reported by mothers at 20 months as a covariate, the results of the ANCOVAs showed that the proportion of child-initiated utterances about agents did not significantly change as a function of their age.

MATERNAL RESPONSES TO CHILDREN'S PROVISION OF INFORMATION (HYPOTHESIS 2)

Responses to children's information-giving utterances about agents

The two turns by mothers following their children's first information-giving utterance about agents for each picture were analyzed. We selected only the first information-giving utterance about agents for each picture because the conversational sequence leading to later information-giving utterances made by the children was probably affected by the first such utterance regarding the picture. Data from only those mother–child pairs in which the child produced information about agents at both 20 and 27 months of age were included in this analysis. Fourteen pairs met this criterion (The mean number of episodes analyzed at 20 and 27 months were 6.1 and 12.3, respectively). Proportions were computed by dividing the number of pictures in response to which mothers produced elaborative information-giving, elaborative information-seeking, and other-repetition utterances following children's information-giving utterances about agents by the number of pictures in response to which children produced information-giving utterances about agents. A series of ANCOVAs showed a main effect of children's age on the proportion of maternal other-repetition utterances, $F(1,12) = 25.20$, $p < 0.001$, $\eta^2 = 0.68$ ($M = 0.94$, SD = 0.09 for the proportion at 20 months; $M = 0.62$, SD = 0.23 for the proportion at 27 months; $M = 5.43$, SD = 4.94 for the number of pictures at 20 months; $M = 8.50$, SD = 4.03 for the number of pictures at 27 months), but no main effect of children's age on the proportion of maternal elaborative information-giving ($M = 0.34$, SD = 0.27 for the proportion at 20 months; $M = 0.17$, SD = 0.15 for the proportion at 27 months; $M = 2.29$, SD = 2.81 for the number of pictures at 20 months; $M = 2.43$, SD = 2.28 for the number of pictures at 27 months) and elaborative information-seeking ($M = 0.17$, SD = 0.18 for the proportion at 20 months; $M = 0.33$, SD = 0.23 for the proportion at 27 months; $M = 1.36$, SD = 1.82 for the number of pictures at 20 months; $M = 4.21$, SD = 2.75 for the number of pictures at 27 months) utterances was observed. The proportion of maternal other-repetition responses to children's information-giving utterances about agents decreased as the children aged from 20 to 27 months (**Figure 2**).

Murase et al. (2005) found that the proportion of maternal elaborative information-seeking utterances was more strongly correlated with children's productive vocabulary size than with children's age. Therefore, we analyzed the correlation between maternal elaborative information-seeking utterances and children's productive vocabulary size at 20 and 27 months. A significant positive relationship was found between the proportion of maternal elaborative information-seeking utterances and children's reported productive vocabulary size when children were 20 months of age [$r(12) = 0.62$, $p < 0.05$], but the relationship between the proportion of elaborative information-seeking utterances and children's observed productive vocabulary size was weaker [$r(12) = 0.38$, n.s.]. Marginally significant positive relationships were found between the proportion of maternal elaborative information-seeking utterances and the size of both the reported [$r(16) = 0.42$, $p < 0.10$] and the observed [$r(16) = 0.43$, $p < 0.10$] productive vocabularies when children were 27 months of age. These results show moderately positive relationships between maternal elaborative information-seeking utterances and the size of children's productive vocabulary.

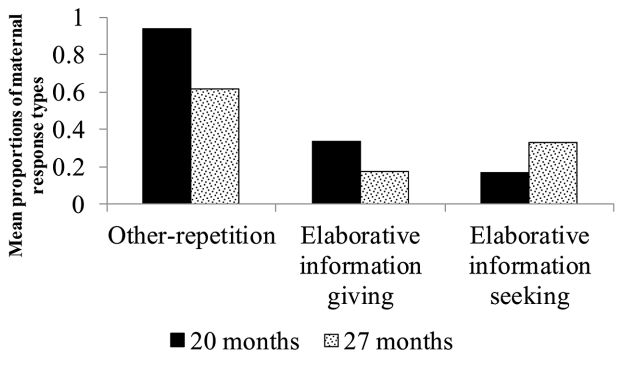

FIGURE 2 | Mean proportions of maternal response types to children's information-giving utterances about agents.

Responses to children's information-giving utterances about actions

The two turns by mothers following their child's first information-giving utterance about actions were analyzed for each picture. We selected only the first information-giving utterance about actions produced by the child for the same reason that we followed this strategy in our analysis of responses to children's information-giving utterances about agents. Only those pairs in which the child offered information about actions at both 20 and 27 months of age were included in this analysis. Data from 10 pairs were used in this analysis (The mean numbers of episodes analyzed at 20 and 27 months were 1.8 and 5.8, respectively). Proportions were computed by dividing the number of pictures in response to which mothers produced elaborative information-giving, elaborative information-seeking, and other-repetition utterances following children's information-giving utterances about actions by the number of pictures in response to which children produced information-giving utterances about actions. A series of ANCOVAs revealed no significant main effect of the proportions of the three dependent variables (**Figure 3**).

RANGE OF REFERENCES IN RESPONSE TO PICTURES (HYPOTHESIS 3)

We categorized the range of references provided by mothers in response to each picture into four types: references to both agents and actions, references to agents only, references to actions only, and references to neither agents nor actions. We categorized the series of utterances in response to pictures as references to agents and actions when mothers provided at least one piece of information about both agents and actions. We categorized responses as references to agents only when mothers offered information about agents but not about actions, even if other information, such as arguments, was provided. We categorized responses as references to actions only when mothers offered information about actions but not about agents, even if other information was provided. We categorized responses as references to neither agents nor actions when mothers did not provide information about agents or actions.

A series of ANCOVAs on the proportions of the four categories (agents and actions, agents only, actions only, and neither agents nor actions) revealed a main effect of children's age on maternal actions-only responses, $F(1,16) = 9.29$, $p < 0.01$, $\eta^2 = 0.37$. The proportion of mothers' actions-only responses decreased between 20 and 27 months of age ($M = 0.19$, SD $= 0.14$ at 20 months; $M = 0.10$, SD $= 0.10$ at 27 months). We found no main effects of children's age on the other three responses (**Figure 4**).

Mothers changed their referential style from information giving to information seeking as their children got older. Moreover, mothers transferred the role of information giving to their children as the children grew older. We included information giving by mothers, information seeking by mothers, and information giving by children in our analyses of the referential style with which mothers and children responded to each picture. A series of ANCOVAs on the proportions of the four categories (agents and actions, agents only, actions only, and neither agents nor actions) again revealed a main effect of children's age on actions-only responses, $F(1,16) = 6.28$, $p < 0.05$, $\eta^2 = 0.28$. The proportion of references to only actions decreased between 20 and 27 months of age ($M = 0.16$, SD $= 0.15$ at 20 months; $M = 0.08$, SD $= 0.11$ at 27 months). Additionally, we also found a marginal main effect of children's age on responses that included references to both agents and actions, $F(1,16) = 3.48$, $p < 0.10$, $\eta^2 = 0.18$. The proportion of references to agents and actions increased between 20 and 27 months of age ($M = 0.41$, SD $= 0.22$ at 20 months; $M = 0.55$, SD $= 0.22$ at 27 months, **Figure 5**). When we used the productive vocabulary size reported by mothers at 20 months, the ANCOVA on references to agents and actions revealed no main effect of children's age.

These results show mothers decreased actions-only references and increased agents-and-actions references as their children got older, although the results for agents-and-actions references are not robust. The results show that mothers did not significantly change the proportion of agents-only references.

EFFECTS OF MATERNAL CONVERSATIONAL STYLES WHEN CHILDREN WERE 20 MONTHS OF AGE ON CHILDREN'S PRODUCTIVE VOCABULARY SIZE AT 27 MONTHS

We first examined the zero-order correlations between maternal conversational styles when children were 20 months of age and children's observed productive vocabulary size at 27 months.

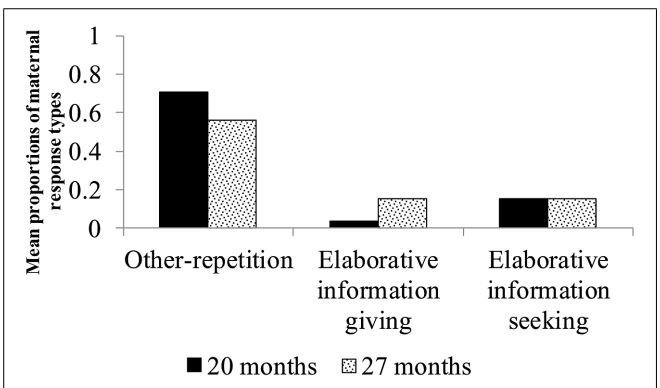

FIGURE 3 | Mean proportions of maternal response types to children's information-giving utterances about actions.

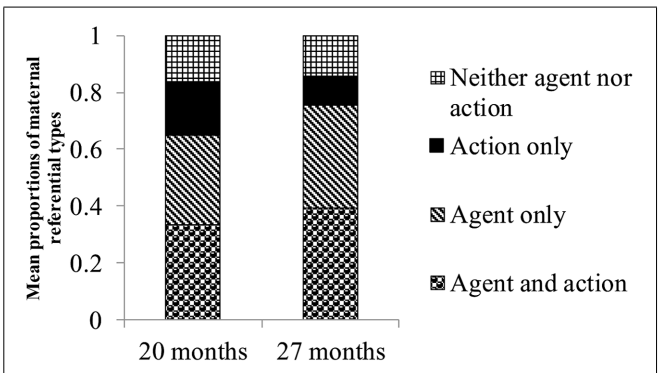

FIGURE 4 | Mean proportions of mothers' referential types for information-giving utterances about a picture.

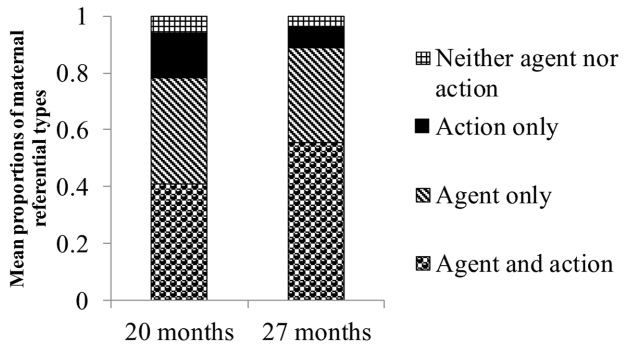

FIGURE 5 | Mean proportions of mothers' and children's referential types for information-giving and information-seeking utterances about a picture.

We then partialed out the factor of children's observed productive vocabulary size at 20 months and examined the association between maternal conversational styles when their children were 20 months of age and children's observed productive vocabulary size at 27 months. We examined maternal conversational styles in terms of initiation styles (proportions of conversations about agents and actions initiated by maternal information seeking and information giving), response styles (proportions of maternal utterances involving elaborative information giving, elaborative information seeking, and other-repetition in response to children's provision of information about agents and actions), and referential styles (proportions of references to both agents and actions, to agents only, and to actions only). These associations are presented in **Table 3**. We found a significant positive zero-order relationship between maternal elaborative information-seeking responses to children's provision of information about agents at 20 months of age and children's observed productive vocabulary size at 27 months [$r(12) = 0.61$, $p < 0.05$]; this association was marginally significant even when we controlled for children's observed productive vocabulary size at 20 months [$r(11) = 0.53$, $p < 0.10$].

Finally, the proportion of maternal elaborative information-seeking responses to children's provision of information about agents was entered into a hierarchical regression analysis, treating children's observed productive vocabulary size at 27 months as the outcome variable. Children's observed productive vocabulary size at 20 months was entered first, followed by the proportion of maternal elaborative information-seeking responses to children's provision of information about agents at 20 months. The results of the hierarchical regression analysis are presented in **Table 4**. Maternal elaborative information-seeking responses to children's provision of information about agents at 20 months was a marginally significant predictor of children's observed productive vocabulary size at 27 months. No other maternal conversational style when children were 20 months of age was a significant predictor when entered in the second step. We also performed a hierarchical regression analysis, treating children's reported productive vocabulary size at 27 months as the outcome variable. We first entered children's reported productive vocabulary size at

Table 3 | Zero-order and partial correlations between maternal conversational styles when children were 20 months of age and children's observed productive vocabulary size at 27 months.

	Zero-order correlation	Partial correlation
Maternal initiation of conversation about agents ($N = 18$)		
Information giving	−0.44†	−0.25
Information seeking	0.26	0.27
Maternal initiation of conversation about actions ($N = 18$)		
Information giving	−0.53*	−0.35
Information seeking	0.58*	0.41
Maternal response to children's provision of information about agents ($N = 14$)		
Elaborative information giving	−0.23	−0.47
Elaborative information seeking	0.61*	0.53†
Other-repetition	−0.47†	−0.09
Maternal response to children's provision of information about actions ($N = 10$)		
Elaborative information giving	0.29	0.58
Elaborative information seeking	0.22	0.15
Other-repetition	−0.13	−0.16
Maternal referential choice ($N = 18$)		
Agent and action	0.48*	0.33
Agent only	0.03	−0.21
Action only	−0.51*	−0.16

*Children's observed productive vocabulary size at 20 months was partialed out in the analysis of partial correlation. *$p < 0.05$, †$p < 0.10$.*

Table 4 | Hierarchical regression analysis on the ability of maternal elaborative information-seeking responses to children's provision of information about agents at 20 months to predict children's observed productive vocabulary size at 27 months ($N = 14$).

	Model 1			Model 2		
	B	**SE *B***	**β**	***B***	**SE *B***	**β**
Children's productive vocabulary size at 20 months	1.23	0.35	0.71**	0.97	0.34	0.56*
Maternal elaborative information-seeking at 20 months				71.00	34.35	0.40†
R^2		0.51			0.65	
F for change in R^2		12.34**			4.27†	

*$p < 0.05$, **$p < 0.01$, †$p < 0.10$.

20 months as the control factor and then entered the proportion of maternal elaborative information-seeking responses. The analysis indicated that maternal elaborative information seeking was not a significant predictor of children's productive vocabulary size at 27 months.

DISCUSSION

The present study revealed that mothers increased the degrees of freedom available to by their children as a function of their children's age in two ways. First, mothers broadened the range of their references by reducing the proportion of references to actions only and increasing the proportion to both agents and actions as their children aged. Second, mothers increased the proportion of conversations about actions that they initiated with information-seeking utterances as the age of their children increased. Maternal elaborative information-seeking responses to children's provision of information include utterances that broadened the range of reference and required that children provide information. Although the proportion of maternal elaborative information-seeking responses to children's utterances providing information about agents did not significantly increase as children aged, the proportion of maternal elaborative information-seeking utterances was moderately positively related to children's productive vocabulary size at both 20 and 27 months. These results indicate that mothers introduce more complex information into their conversations with their children and transfer the role of actively producing information during conversations to their children as their children develop.

Maternal elaborative information-seeking responses to children's provision of information about agents at 20 months was positively associated with children's observed productive vocabulary size at 27 months. This result suggests that maternal responses that elaborate on information provided by their children and require children to adopt an active role in producing information promote the development of children's vocabularies during the period from the one-word to the syntactic stage.

In addition to the aforementioned increase in the degrees of freedom, the present study revealed that mothers reduced the proportion of utterances designed to maintain their children's attention and provide models, the other aspects of scaffolding. Mothers reduced other-repetition in their responses to children's provision of information about agents as children developed. We discuss the individual maternal conversational styles in greater detail in the following sections.

INITIATION OF CONVERSATION

In terms of conversations about actions, mothers reduced initiation by information giving and increased initiation by information seeking from 20 to 27 months, as proposed by Hypothesis 1. Contrary to Hypothesis 1, mothers did not initiate a significantly larger proportion of conversations about agents by information seeking, although they did initiate a smaller proportion of such conversations by information giving during this interval.

The absence of an increase in the proportion of conversations about agents initiated by information seeking can be explained by the age range of the children in this study. The mothers of the 20-month-old children included in the present study initiated conversations about agents in more than 50% of the episodes on average, which exceeded the proportion of conversations about actions initiated by information seeking by mothers of 27-month-old children. Previous studies have shown that the proportion of conversations initiated by maternal information-seeking utterances while reading picture books about objects substantially increased during the first half of the second year of their children's life; however, the rate at which such utterances increased was reduced during the second half of the children's second year (DeLoache and DeMendoza, 1987; Murase et al., 1998). The mothers of 20-month-old children included in the present study reached the level at which they frequently initiated conversations about agents with information-seeking utterances.

Why do mothers frequently initiate conversations about agents by information seeking when their children are 20 months of age? The first reason for this is the earlier acquisition of words about agents than about actions. Children produce utterances about agents more frequently than about actions starting at 20 months of age. Another reason for this finding is the order of conversations. In general, conversations about agents precede those about actions. At the beginning of such conversations, mothers are likely to use rhetorical questions that take the form of information-seeking utterances in the absence of an expectation of a reply from the addressee (DeLoache and DeMendoza, 1987). When mothers start a conversational episode about a picture, they may use rhetorical questions for the purpose of attracting children's attention irrespective of whether the mothers expect an answer.

In summary, mothers shift their approach to initiating conversations from information giving to information seeking during the second year of their children's lives. This shift occurs first in conversations about agents and next in conversations about actions. It represents an increase in the degrees of freedom in the scaffolding process that are controlled by children (Wood et al., 1976).

RESPONSES TO CHILDREN'S INFORMATION-GIVING UTTERANCES

As hypothesized (hypothesis 2) mothers decreased other-repetition responses to children's information-giving utterances about agents as their children aged from 20 to 27 months. This result is consistent with previous research (Murase et al., 1998). In general, previously established referents are more likely to be expressed in non-lexical (null or pronominal) forms than are newly introduced referents (Guerriero et al., 2006). In contrast to this principle, mothers of younger children may repeat referents that have been previously expressed by their children in an idealized form with the expectations that the children will imitate them and that the repetition will maintain their children's focus on the ongoing conversation. The results show that mothers reduced these types of scaffolding (i.e., demonstration and direction-maintenance) as their children aged.

However, contrary to hypothesis 2, mothers did not significantly change the proportion of elaborative information-seeking and elaborative information-giving utterances in response to children's information-giving utterances about agents as their children developed from 20 to 27 months. Elaborative information seeking can be viewed as providing less scaffolding and raising the ante because it adds new information to that provided by children and it asks children to produce information. Why did elaborative information-seeking responses not increase with children's age? Mothers may decide whether they require elaborative information from their children based on their children's ability to produce lexical utterances because maternal elaborative information-seeking responses are requests made after children provide information; this differs from requests for information that initiate conversations. In effect, the present study found a moderately positive relationship between the proportion of maternal elaborative information-seeking responses and children's productive vocabulary size. This finding is in accord with the fact that the increase in the elaborative information-seeking utterances by Japanese mothers in response to their children's labeling is more strongly related to their children's productive vocabulary size than to their general developmental level, as represented by their children's age (Murase et al., 2005).

Mothers' responses to information-giving utterances about actions made by children did not change with children's age. One reason that no such change was found could be the small number of information-giving utterances about actions produced by children. More data are required to reach conclusions about mothers' responses to this kind of utterance. Another reason for the absence of an association between these utterances and children's age involves the order in which the conversations proceeded. In response to many of the pictures, mothers and children started conversations by referring to the agents, and their references to actions came later. Mothers' responses to children's information-giving utterances about actions may have been affected by the preceding conversations about agents, which may have masked changes in mothers' responses as children got older.

MOTHERS' REFERENTIAL CHOICES

Mothers broadened the range of their references as their children developed from 20 to 27 months. As hypothesis 3 proposed, the proportion of references to actions only decreased with children's age. However, the proportion of references to both agents and actions did not significantly increase with children's age when we limited the analysis to mothers' information-giving utterances. When we considered the shift from providing to requesting information and the passing of the role of providing information from mother to child, we added information-seeking utterances by mothers and information-giving utterances by children to the category. We found that the proportion of references to agents and actions tended to increase as the children developed from 20 to 27 months, although this result was not robust.

Contrary to hypothesis 3, the proportion of references to agents only did not change with children's age. This can be explained by the dominance of agentic references in this situation. Japanese mothers are more oriented to nouns/naming than to verbs/activity during mother–child conversations while reading picture books (Ogura et al., 2006). When their children are 20 months of age, mothers refer to things that can interest or be comprehended or produced by their children irrespective of whether the referents are agents or actions. When children reach 27 months of age, mothers focus on agentic references, on the one hand, while broadening the range of references, on the other.

In summary, mothers tend to broaden the range of references as their children grow older, which can be viewed as raising the ante because mothers appear to introduce more complex conversations to their children. This can also be viewed as reducing the degree of scaffolding because mothers tend to encourage their older children to be in control of a wider range of information. However, mothers also shift their focus toward agentic references as their children develop, and the decrease in references to agents only may in part reflect this shift.

CONTRIBUTION OF MATERNAL ELABORATIVE INFORMATION-SEEKING UTTERANCES TO CHILDREN'S VOCABULARY DEVELOPMENT

The hierarchical regression analysis showed that maternal elaborative information-seeking responses to children's information-giving utterances about agents at 20 months of age marginally predicted increases in children's observed productive vocabulary size. Although not robust, this result suggests that maternal conversational style can contribute to children's language development as children transition from the one-word to the syntactic stage.

Maternal elaborative information-seeking utterances have three important characteristics. First, they extend the scope of conversations in that mothers use them to add new information. The results of the present study are consistent with findings that maternal lexical richness, which is exemplified by elaborative information-seeking utterances, exerts a positive effect on children's vocabulary development (Bornstein et al., 1998; Hoff and Naigles, 2002). Second, maternal elaborative information-seeking

utterances act as requests for children to take an active role in the conversation by providing information. The results of the present study are consistent with findings that dialogic reading is positively related to children's language development in that it includes asking wh-questions and following children's answers with questions (Arnold and Whitehurst, 1994). Third, maternal elaborative information-seeking utterances are responsive in that they are contingent on and appropriately connected to children's utterances. The results of the present study are in accord with earlier research indicating that maternal responsiveness contributes to children's vocabulary development (Tamis-LeMonda et al., 2001; Tamis-LeMonda and Bornstein, 2002).

In summary, adding new information, requesting information, and being responsive may contribute to children's vocabulary development during the transition from the one-word to the syntactic stage.

LIMITATIONS AND FUTURE DIRECTIONS

The conclusions drawn from this study and their generalizability are limited by some aspects of the design. Although the 7-min observation period was substantial, only a modest number of information-giving utterances were provided by some children. Thus, the power of this research to analyze maternal responses to children's provision of information was limited. Additionally, we did not analyze information about arguments because too few relevant utterances were made.

The results regarding increased references to both agents and actions and the contribution of maternal elaborative information-seeking utterances to children's vocabulary development are not robust. Additional research is needed to confirm these results.

Conversations during reading other types of books (e.g., story books) need to be investigated because the types of utterances made by mothers change according to the kinds of picture that is viewed (Chan et al., 2009). It would also be interesting to examine conversations that occur while mothers and children are viewing animated scenes. Indeed, unlike the static scenes used in this study, animated scenes may elicit more utterances about actions from mothers and children during joint watching. Furthermore, conversations during joint picture-book reading are more focused on labeling than are conversations in other situations, such as playing with toys. It would be important to investigate whether mothers modify their utterances in other situations in a way that is similar to the patterns observed in the present study.

Japanese is a pro-drop language, and we need to investigate whether our findings about referential choice can be generalized to the speakers of other languages. For example, in English, the agents, actions, objects, and recipients are all explicitly mentioned. We need to examine whether English-speaking caregivers change the range of their references as a function of children's age.

Another interesting topic for future study would be cross-cultural comparisons between East Asian and North American caregivers. Although information about differences in the attentional styles of East Asians and North Americans has been increasing (Masuda and Nisbett, 2001; Masuda et al., 2008), only a few studies have attempted to clarify the developmental processes underpinning cross-cultural differences (Chan et al., 2009). Thus, the comparisons of the referential choices made by Japanese and American caregivers need to be investigated from a cross-cultural perspective.

CONCLUSION

This study determined that Japanese mothers decrease scaffolding and raise the ante by changing the balance between providing and requesting information and by broadening their range of references. This study also suggests that maternal elaborative information-seeking responses contribute to children's vocabulary development. Cross-cultural studies will clarify the universality and culture-specific aspects of these characteristics and elucidate the developmental processes underlying children's language development.

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Children's interactions with iPad books: research chapters still to be written

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Children's interactive e-books are novel literacy tools with interactive and multimodal representations of story contents and increased customizable features. The learning opportunities represented by these new affordances demand a thorough consideration of children's engagement, including the contextual and socio-cultural factors which influence the books' deployment in home and classroom settings. Currently, there is inconclusive evidence about how the affordances of interactive e-books support children's learning, with studies mostly limited to comparison studies with non-digital books and observational studies of children's immediate engagement. In both lines of research, the content of the stories, the overall context of interaction and the background of the interactants are neglected. This article makes recommendations for future research and highlights the value of iPads as a new medium enriching children's experiences but also challenging traditional research assumptions.

CHILDREN'S iPad BOOKS: AFFORDANCES AND DISTINCTIVE FEATURES

Children's interactive e-books are touch-manipulative digital books which represent meanings in three modes (i.e., sound, text, and image) and offer several possibilities for interaction (e.g., main character moves when touched). They differ from paper-based books and from classic PC books according to several dimensions, summarized in **Table1**.

Children's interactive e-books can be downloaded on several devices such as smartphones and tables. Those downloaded on iPads can be of two kinds: those created by the users themselves using any of the "book-making apps" available in App store (e.g., My Story™, Our Story) or "iPad storybooks" which are ready-made and can be downloaded from the ibook store (e.g., Cinderella™, What is That?). In practice, book-making apps often accompany iPad storybooks or are even integrated into them (e.g., the Farmer's Lunch app by HarperCollins). In this piece, I focus on interactive e-books downloaded on iPads and subsume under the term "iPad books" books created with book-making iPad apps or those which are commercially available.

iPad books come with several activities (e.g., possibility for coloring the storybook pages) and customization or personalization options. The features which have not been available for children's books before are increased interactivity, multimodal story representation and unprecedented customizability of reading experience. Considering these novel features and the increased popularity and growing industry of children's iPad books (Costello, 2012), it seems important to research the books' potential for supporting children's learning and engagement with literacy.

RESEARCH TO DATE: ISSUES AND PROMISING AVENUES

So far, research concerning children's iPad storybooks has focused on two approaches: observational studies nested in qualitative research and comparison studies which tend to adopt quantitative research design. In the former approach, researchers have documented children's engagement with a variety of iPad apps, including book-making (or story-making) apps in classrooms. For example, Hutchison et al. (2012) investigated how iPads support children's reading and responding to text in elementary classrooms. Several apps were investigated, including three book-making apps: iBooks, Strip Designer and Popplet. Teachers' reports and the researchers' observations indicated that iBooks were primarily used for independent reading in the classroom, while the Strip Designer and Popplet apps were used for children's creative story-composing. Both kinds of books seemed to engage and motivate children to practice new literacy skills, such as cooperation, creativity or self-revision. Similarly, Flewitt et al. (2012) have documented young children's engagement with various apps in a primary and pre-school classroom, including a book-making app called Our Story. Children were found to be meaningfully and creatively engaged with Our Story and the teachers positively commented on the app's potential to support children's digital literacy and inventiveness.

In another line of research, Parish-Morris et al. (2013) compared children's touch-sensitive electronic console books (comparable to iPad storybooks) and traditional books in relation to dialogic language and children's story comprehension. The authors observed 165 parent–child dyads and found that children's story comprehension was negatively influenced by the presence of electronic features in the electronic console books. Chiong et al. (2012) investigated the differences between basic e-books (i.e., digital books with minimal interactive and customization features) and enhanced

Table 1 | Overview of affordances of three main reading tools for children.

	Audio representation	Visual representation	Touch screen	Interactivity	Customization	Personalization
Books	No	Yes	No	No	No	No
PC books	Yes	Yes	No	Yes	Yes	Yes
E-books*	Yes	Yes	Yes	Yes	Yes	Yes

**E-books can be downloaded to various devices, including smartphones, Kindle and iPads.*

e-books, as read by 32 parents and their 3–6-year-old children. Chiong et al. analyzed their observational data along several dimensions, including physical and verbal engagement, story recall, as well as verbal labeling, or pointing in relation to specific story features. The findings showed that the enhanced interactivity of e-books negatively affected children's story recall but was advantageous for engaging children in the activity and prompting physical interaction.

Thus, it seems to be the case that in comparison studies, iPad books fare less well than traditional books, but when studied in their own right, iPad books are reported to engage children and to have positive effects different from simple digital books. However, in drawing these conclusions, it is important to recognize some persistent issues in research concerned with children's interactions with technology. Moreover, methodological inconsistences among the studies limit the insights into the research implications. This leaves many practitioners uncertain about how to best support children's interaction with the tools (Kucirkova, 2013). To help guide future research and development in this area, I suggest some theoretical and methodological considerations.

THEORETICAL POINTERS

I argue that to empirically illustrate the novel affordances of iPad books, researchers need to follow theories which view digital texts as a new medium of communication, and new technologies as tools which afford novel learning spaces. Researchers who evaluate children's learning experiences need to consider traditional as well as new digital literacy skills which are opening out with new technologies. For the latter, children's ability to interpret digital images or to collaborate on a piece of text are relevant (Wolsey and Grisham, 2012). Such an approach resonates with the proponents of the New Literacies Framework, who associate new technologies with new definitions of literacy (Coiro et al., 2008). New Literacies Framework puts forward the idea that new technologies reshape the ways in which stories are presented and interpreted (Lankshear and Knobel, 2003) and that their mastering and understanding requires new literacy skills. Such a position builds upon previous theoretical work which views new forms of books as new literacy tools with unique affordances for meaning-making (Salomon, 1992). These views are supported by historical evidence outlined by Madej (2003) who reviewed the evolution of interactive features in digital texts and concluded that new digital texts are more than an extension or replacement of previous books. Even though there were various media accompanying books as early as in the 1980s (such as an audio tape or television show to enrich a paper-based story), there was a considerable shift of story presentation in the 1990s, with new technologies "reshaping stories" (Madej, 2003, p.15). Therefore, researchers interested in finding out how novel features of iPad books affect children's learning, need to adopt a theoretical framework which facilitates conceptualizing iPad books as unique, 21st century learning tools. This is closely linked to the need for adopting a detailed and innovative methodology to ascertain the books' value for children's learning.

METHODOLOGICAL POINTERS

Some steps in adopting new methodological approaches to study children's iPad books have been already undertaken. For example, Falloon (2013) applied an innovative methodology to generate and analyse data from the use of iPads by eighteen 5-year-olds in a New Zealand preschool classroom. Faloon used the Display Recorder app with which he could record children's interaction from within the device, generating video files with detailed finger placement indication and good sound quality. This procedure allowed the researcher to collect data reflecting children's natural interaction and minimize observer-effect which often occurs from close observation or video recording. Moreover, a complex list of factors influencing children's engagement was obtained, including effects which reflect teachers' ability to adequately support the children, such as modeling the child's response or offering corrective and formative feedback (Falloon, 2013). Although a new analytical framework might pose difficulties for direct comparisons with findings from previous research with traditional paper-based books, it offers powerful opportunities for future design of iPad books, both in terms of their content and format features. It is likely that a thorough consideration of the nature of interactive features, designed with or without a pedagogic intention in mind, will help designers gather specific data on the process of children's engagement and establish possible areas of concern.

Existent qualitative methodologies offer another promising research avenue in this respect. Kucirkova et al. (2013) looked in detail at a parent-child interaction when reading a self-made book on iPad. A detailed multimodal interactional analysis approach allowed the authors to analyse the interaction along verbal and non-verbal interaction indices (Norris, 2004) and to distinguish between verbal and non-verbal communication and "embodied (gesture, gaze and language) and disembodied (e.g., a book, iPad, and picture) resources used for meaning-making" (Kucirkova et al., 2013, p. 117). In addition to the analysis of communicative modes of the parent and child, Kucirkova et al. considered the communication modes of the audio-visual book, i.e., the sounds and images which were part of the story the mother and child viewed and interacted with during story-sharing. The

study showed that parent-child sharing of the personal iPad book can give rise to a new interactional space, resembling the atmosphere of experiencing a piece of art. The study thus underscored the importance of future research to consider the possibility that iPad books can establish a new interaction context which needs to be studied with comprehensive and detailed methodologies.

In addition to methodological innovations and creative research approaches, future research agendas need to combine innovation with some well-known, yet often neglected, issues in technology research. In this respect, my recommendations for future research focus on three areas.

First, future research needs to consider children's engagement in light of factors related to interaction with technology. Notably, children's previous exposure to iPads, technological competency, gender and overall literacy skills are likely to play a role in children's engagement with iPad books (see Plowman, 1995).

Second, future research should involve an examination of the interlinked relationship between iPads' use and home and classroom literacy practices. It has been well established that the use of books is heavily influenced by the classroom practice preceding their introduction (Ertmer, 1999; Windschitl and Sahl, 2002) and that teachers' beliefs and instructional philosophy are often a more powerful determinant of technology use than the technology itself (Miller and Olson, 1994). It follows that for books presented in the form of digital apps or texts, teachers' classroom practice and their conception of the nature of children's interaction with books and technology are vital variables to be included in analyses. By the same token, parents' attitudes and beliefs about appropriate early literacy activities ought to be considered as a crucial element in future parent-child-iPad book investigations (see e.g., Bingham, 2007).

Finally, future research should study in detail the *content* of the iPad storybooks children engage with. In light of the well-established effects of different book contents on children's learning (e.g., Nyhout and O'Neill, 2013), it is important to enrich existing findings with a detailed examination of the variety of contents iPad books can accommodate, ranging from self-generated innovative storybooks through conventional alphabet and information books.

In conclusion, iPad books for children are a novel addition to the rich repertoire of children's books in the 21st century. A small but emerging literature exists which shows inconclusive evidence of the books' benefits for young children. In view of the current belief that new literacy activities ought to foster children's current *and* future literacy skills (Barone and Mallette, 2013), researchers need to be mindful of issues related to the evaluation of new and traditional literacy practices. Future research needs theoretically sound and methodologically innovative examinations of the ways in which iPad books add to children's literacy experiences.

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Structured narrative retell instruction for young children from low socioeconomic backgrounds: a preliminary study of feasibility

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Successful acquisition of literacy depends on adequate development of decoding skills as well as broader, meaning-related knowledge and skills for text comprehension. Children from low socioeconomic status (SES) backgrounds are often challenged in both domains, relative to peers who are not economically disadvantaged. The efficacy of code-focused instructional programs for at-risk preliterate children is well supported, but less evidence is available regarding interventions to improve broader language and comprehension skills. This preliminary study tested the feasibility of a new intervention, "structured narrative retell instruction" (SNRI), and explored its potential to enhance meaning-related knowledge and skills, including vocabulary, listening comprehension, and narrative skills, in pre-literate, low SES children. SNRI used authentic children's books to model comprehension processes, explicitly teach story grammar, and implicitly target microstructural aspects of narratives. Participants included 9 children with a mean age of 60 months, who were randomly assigned to SNRI or to code-focused literacy instruction (CFLI). Each group received 12, 40-min instructional sessions over 6 weeks. Pre- and post-tests were administered to assess vocabulary, listening comprehension, narrative macrostructure and narrative microstructure, as well as alphabet knowledge, phonological awareness, and concepts of print. The feasibility of SNRI was demonstrated by completion of the designed study, moderately high treatment fidelity, and qualitative feedback from interventionists. The SNRI group also made significant gains on 4 of the 7 meaning-related measures ($p < 0.10$). In comparison, the CFLI group made significant gains on 2 of 7 meaning-related measures. We conclude that SNRI is feasible and shows potential for improving language skills related to comprehension and that further research investigating its efficacy is warranted.

Keywords: preschool, literacy, narrative language, listening comprehension, book reading, macrostructure, microstructure, feasibility

INTRODUCTION

Children from low socioeconomic status (SES) backgrounds have an elevated risk for language and reading difficulties and related academic consequences, as compared with peers from middle and upper class backgrounds (Brooks-Gunn and Duncan, 1997; McLoyd, 1998; Denton and West, 2002). Hair et al. (2006) reported that approximately one-fourth of all kindergarteners enter school with language development that is behind that of their peers, but children of poverty tend to carry this "risk" profile with higher frequency than their peers from mainstream environments. Moreover, these achievement gaps are observable across school grades. For example, Fiester (2010) reported that 83% of fourth-grade students from low-income families performed below proficiency standards on the National Assessment of Educational Progress (NAEP) reading test, as compared with 55% of students from moderate to high-income families.

Students who are from economically disadvantaged backgrounds may be especially challenged in their abilities to maintain levels of performance commensurate with peers from economically secure households as they progress through school (Chall and Jacobs, 2003; Pianta et al., 2008). Some evidence suggests that early-emerging disparities in educational attainment related to socio-economic factors may become more substantial over time due to a phenomenon referred to as the Matthew effect (Bast and Reitsma, 1998; Morgan et al., 2008; McNamara et al., 2011; Morgan et al., 2011; but see Baumert et al., 2012). The Matthew effect is demonstrated when children with weak initial performance are less able to benefit from learning opportunities than their higher-skilled peers (Burstall, 1978; Stanovich, 1986). Other research, while not specifically testing for the Matthew effect, emphasizes the stability of early literacy delays (Juel, 1988; Cunningham and Stanovich, 1997; Cabell et al., 2013). For example, in a recent longitudinal study of preschoolers from low SES homes, Cabell et al. (2013) found that emergent literacy profiles based on performance in the fall of the preschool year were highly stable, especially for highest and lowest achievers. Of the children in the lowest achievement group in the fall, only 21% moved into

the average range by spring. Interestingly, those children who did make an upward shift in ranking had higher initial levels of oral language abilities. Taken together, these findings underscore the need for evidence-based interventions to close the gap for disadvantaged students early on, to develop a strong language and literacy foundation that yields success in school and life.

Successful acquisition of literacy depends on adequate development of decoding skills as well as broader language skills for text comprehension (Storch and Whitehurst, 2002). As a group, children from low SES backgrounds enter school with lower performance in both domains, including delays in alphabetic knowledge and phonological awareness, which support the acquisition of decoding abilities, and delays in meaning-related knowledge and skills, e.g., vocabulary, syntax, higher-level language skills, and world knowledge, which contribute to the development of reading comprehension (Hart and Risley, 1995; Lonigan et al., 1998; Hirsch, 2003; Durham et al., 2007; Huttenlocher et al., 2010). Research over the last three decades has provided strong evidence documenting the efficacy of interventions that explicitly and systematically target code skills in preschool-aged children of low SES backgrounds. Comprehensive reviews of research have concluded that explicit instruction in alphabet knowledge, phonological awareness, and letter-sound relationships leads to significant improvements in children's reading and spelling abilities, including children from low SES homes and other at-risk groups (National Reading Panel, 2000; National Early Literacy Panel, 2009; Piasta and Wagner, 2010). In contrast, there is less evidence for interventions that close performance gaps in the broader language skills that support the development of reading comprehension abilities, although a body of positive evidence is beginning to emerge (cf. National Early Literacy Panel, 2009; Fricke et al., 2013).

Shared book reading interventions are probably the most commonly studied oral language interventions for young pre-readers, as can be observed in recent meta-analyses by the National Early Literacy Panel (2009) and Swanson et al. (2011). The largest group of studies included in these syntheses has examined a method of shared storybook reading, termed "dialogic reading" in which parents or teachers try to engage a child in a conversation about the storybook during reading by asking open ended wh-questions, repeating the child's correct responses, and following the child's lead with the goal of having the child gradually take the lead in the book discussion (e.g., Lonigan and Whitehurst, 1998). Other shared book reading interventions have included a focus on teaching new vocabulary from storybooks (e.g., Beck and McKeown, 2007), using limited questioning to foster comprehension skills (e.g., Morrow, 1988) or computer-administered read aloud sessions (e.g., Verhallen et al., 2006). From these studies, it is clear that shared book reading activities help to improve children's vocabulary knowledge. However, relatively few studies examined effects for other aspects of oral language, such as syntax, narrative macrostructure and microstructure, and general listening comprehension (but see Reese et al., 2010). The two aforementioned research syntheses provided effect sizes for vocabulary compared to other oral language measures (e.g., norm referenced measures of receptive and expressive language, language sample measures, qualitative and quantitative measures of narrative retells). Although significantly positive effect sizes were obtained for oral language across studies [$ES = 0.30$ and $ES = 0.35$ in National Early Literacy Panel (2009) and Swanson et al. (2011), respectively], these effect sizes were smaller than those obtained for vocabulary ($ES = 1.02$ and $ES = 0.60$). Clearly, more research is needed to examine effects on multiple components of language, and identify interventions that have effects large enough to help close gaps for at-risk children.

The purpose of this study was to examine the feasibility of a new intervention program focused on retelling narratives from authentic children's books and to determine if it showed promise of effectiveness for improving meaning-related knowledge and skills in preliterate children from low SES backgrounds. We called this program "Structured Narrative Retell Instruction" (SNRI), and our rationale for developing it was based on previous research on shared book reading, as well as other research focused on children's comprehension and production of narratives.

First, research indicates that children's understanding of narrative structure develops prior to their comprehension of print and correlates with their later reading comprehension abilities (Bishop and Edmundson, 1987; Fazio et al., 1996; Kendeou et al., 2005; Oakhill and Cain, 2007; Dooley and Matthews, 2009; Wellman et al., 2011). These narrative skills are often weakened in children with language and learning difficulties (Merritt and Liles, 1987; Scott and Windsor, 2000; Cain, 2003; Fey et al., 2004). For example, a recent study of at-risk first grade children reported that responders and non-responders to brief code-based interventions showed significantly different performance on the pre-intervention assessments of narrative language skills (Allen et al., 2012). Second, narrative interventions involving story grammar analysis have generally been shown to be effective in improving reading comprehension skills in older, school-aged children (Dimino et al., 1995; National Reading Panel, 2000; Shanahan et al., 2010). Third, although relatively few studies have included preschool-aged children, there is some evidence that narrative-based language interventions can be successful for children who exhibit language impairments and other developmental delays (Petersen et al., 2010; Spencer and Slocum, 2010). Petersen (2011) reviewed narrative intervention studies involving children with language impairments or learning disabilities of the nine studies included in the review, three included at least some preschoolers in their participant sample (Tyler and Sandoval, 1994; Hayward and Schneider, 2000; Davies et al., 2004). Across all of the studies reviewed, children with language impairments benefited from narrative interventions, with gains observed in grammar skills, vocabulary, and narrative structure. Additionally, focusing on narratives during oral language intervention provides a medium for clinicians to target both lower- and higher-level language skills simultaneously, using both direct and indirect methods. For example, while eliciting narrative retells from children, clinicians can use modeling, expansion, prompting and elicited imitation to promote children's understanding and use of more advanced syntactic structures (e.g., Swanson et al., 2005).

Most previous studies targeting narrative skills in pre-readers have used researcher-designed narratives and/or wordless picture books to teach and elicit narratives (e.g., Hayward and Schneider, 2000; Davies et al., 2004; Swanson et al., 2005; Peña et al., 2006;

Petersen et al., 2008; Spencer and Slocum, 2010; Allen et al., 2012; Green and Klecan-Aker, 2012;). These procedures help researchers provide greater control over the story structure and narrative components, as well as the length and linguistic complexity of narrative materials. However, we developed SNRI to focus on narrative stories from authentic published children's storybooks. Several factors led to this decision. The first involved ecological validity: If the ultimate goal is to improve later reading comprehension outcomes, it seems fitting to expose children to authentic texts as much as possible. As discussed previously, there is also a sizeable research base showing the benefits of shared book reading activities for vocabulary development (National Early Literacy Panel, 2009; Swanson et al., 2011; see also Cunningham and Zibulsky, 2011). Further, published children's storybooks often contain engaging artwork that can help make book reading and book discussions more enjoyable for young children. Lastly, although our study did not address home literacy activities, if our intervention was found to be effective, it is possible that it could be adapted in the future for implementation by parents in the home. We hypothesized that authentic children's books would likely be easier to incorporate into home literacy activities than experimenter-developed stories.

In an evidence-based practice framework, large-scale, fully powered randomized controlled trials (RCTs) are considered the "gold standard" for making treatment decisions (Rosen et al., 2006). However, these studies can be extremely costly in terms of human resources, time, and participant effort, leading some to suggest that careful consideration should be given to their usage (Sibbald and Roland, 1998; Stolberg et al., 2004). Consequently, it is prudent to establish the feasibility of an intervention during its development period, before proceeding with larger investigations. In the early phases of clinical outcomes research—including the process during which intervention is being developed—preliminary, small-scale investigations that are often exploratory in nature are important for helping researchers to determine if large-scale studies are viable pursuit (Robey, 2004; Fey and Finestack, 2009). From such investigations, researchers are able to assess whether or not the developed intervention can be implemented with fidelity within the target population, as well as whether the ideas and outcomes are able to be modified and sustainable (Bowen et al., 2009). Thus, the ultimate goal of our study was to determine whether a RCT investigating SNRI was warranted, or whether further development of the intervention was needed.

In sum, the goal of the current study was to determine whether the previously untested SNRI was feasible and whether it showed promise of being effective for improving meaning-related skills in at-risk, preliterate children. Our research questions included: (1) Is SNRI viable in its current form, or are modifications necessary prior to pursuing a larger-scale study? (2) Do children receiving SNRI show improvement in their vocabulary knowledge, narrative understanding, or narrative production skills? To address these research questions, we implemented SNRI within a childcare center that served low-income families. Because these participants could already be considered to be at risk for language, reading, and future academic difficulties due to economic disadvantage, we did not wish to withhold treatment from one group as a no-treatment control condition. Instead, we contrasted effects of SNRI with an intervention that focused on code skills, Code-Focused Literacy Instruction (CFLI). Which also used authentic children's storybooks but targeted letter knowledge, phonological awareness, and print knowledge. Previous research with preschoolers indicates that instruction in code-based skills does not generalize to comprehension skills and vice versa (e.g., Gamse et al., 2008; Bianco et al., 2010). These findings suggest that CFLI could serve as an appropriate, albeit conservative, control against which to compare the experimental SNRI. Our hypotheses were that (1) SRNI would be able to be implemented with fidelity, and (2) that children receiving SNRI instruction would be more likely to demonstrate gains in meaning-related knowledge and skills (i.e., on assessments of vocabulary, narrative understanding, and narrative production) than children receiving CFLI instruction.

METHODS

PARTICIPANTS

Participants were recruited from a childcare center in Columbia, South Carolina, US that primarily served economically- disadvantaged families. Most of the families who patronized the childcare center received state assistance to pay for childcare while they worked or participated in job-related education or training. The center staff was asked to distribute study information and informed consent forms to parents of all enrolled children between 3 and 6 years of age ($n = 25$). Ten child participants aged 49–82 months (7 preschool, 2 kindergarten, 1 first grade) were initially recruited. All children were African American and spoke English as their first and only language. Prior to the instructional interventions, children were randomly assigned to receive either SNRI or CFLI treatment. One child from the SNRI group moved after the first week of intervention; thus, all study analyses focus on the five children in the CFLI group and four children in the SNRI group who completed all pre-test, intervention sessions, and post-test sessions. Each of these children had perfect attendance or made up any missed sessions prior to post-testing. Each child received free copies of each book used in the intervention, for a total of 10 books (two books were used in two intervention sessions each).

MEASURES

Participants were presented a battery of assessments designed to characterize their individual language and cognitive profiles. Some tests were administered to provide a detailed profile of the children's speech, language and cognitive skills prior to the intervention, whereas others were used to measure change in targeted skills across the intervention period. All of the testing occurred in individual sessions in a quiet area of the center. The examiners were graduate students in speech-language pathology who had received training regarding the tests' administration and scoring procedures prior to meeting with the participants. A Ph.D. faculty member supervised each student examiner and was available on site to provide guidance and answer questions as needed. All sessions were audio recorded and video recorded for data analysis and reliability checking. Unless otherwise noted, all standardized assessments were double-scored by trained research staff to

ensure reliability of scoring. All disagreements were resolved by discussion with the first author.

Pre-intervention descriptive measures

First, nonverbal cognitive abilities were measured with two subtests from the Leiter International Performance Scale-Revised (Leiter-R; Roid and Miller, 1997). The Figure Ground subtest measures a child's ability to identify an embedded figure within a complex picture. The Form Completion subtest measures a child's ability to recognize a whole picture from separate pictures of its parts. Next, basic receptive and expressive language abilities were assessed using the Basic Concepts and Parallel Sentence Production subtests of the Assessment of Language and Literacy (ALL; Lombardino et al., 2005). In the Basic Concepts subtest, participants are asked to point to pictures that represent concepts described by the examiner (e.g., size, location, comparison). The Parallel Sentence Production subtest evaluates a child's production of grammatical morphemes and syntactic structures. Following the procedures of the test manual, acceptable dialectical variations received full credit.

Pre-and post-test measures of intervention targets

Receptive vocabulary. The Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4; Dunn and Dunn, 2007) was used to measure receptive vocabulary knowledge. For this test, the examiner presented a series of pictures, with four pictures per page, to the participant. The participant was required to point to the picture that was named or described by the examiner.

Listening comprehension. The preschool section of the ALL Listening Comprehension subtest (Lombardino et al., 2005) was presented. For this subtest, participants listened to three brief stories, each read twice by the examiner. After a story was read the first time, participants were asked to retell the story back to the examiner. Then the story was read a second time, and participants were asked to answer three to four comprehension questions about the story. Responses from the retells and comprehension questions were scored from audio recordings by trained research assistants according to the test manual, which awarded binary credit for inclusion of specific content elements from the story. The maximum possible score across the three stories was 21.

Narrative macrostructure. A finer-grained assessment of participants' narrative skills was obtained by transcribing and coding transcripts of participants' retells of the three preschool stories from the ALL Listening Comprehension subtest. To assess narrative macrostructure, each transcript was scored based on the following five components: characters, initiating event, character response, remaining events, and end of story. Each component received a score between 0 and 2, depending on the accuracy and amount of detail provided. For example, when all characters were referred to with nonspecific labels (e.g., "the boy" or "the girl"), one point was awarded for the character component, whereas when specific character names were used, two points were awarded. Scores for all components across all stories were summed, for a maximum possible score of 30. To ensure reliability of macrostructure scores, two trained research assistants coded macrostructure for each narrative. The correlation between total scores assigned by each rater was 0.99.

Narrative microstructure. To assess narrative microstructure, transcripts were coded and analyzed for length, lexical diversity, and grammatical complexity using SALT: Systematic Analysis of Language Transcripts software (Miller and Iglesias, 2012). Because the original stories were relatively short, the transcripts for the three stories were combined and analyzed as one unit. The total number of words across the three stories served as the outcome measure of length, and the number of different words served as the outcome measure of lexical diversity. Two measures were used to assess grammatical complexity, and both involved parsing the transcript into C-units. A C-unit is an independent clause (i.e., a "main clause") with all its subordinate clauses. The first measure of grammatical complexity was the mean length of utterance (MLU), which was the average number of words per C-unit. The second measure of grammatical complexity was the clausal density, or the average number of clauses per C-unit. To achieve accurate and reliable microstructure measures, two trained research assistants separately entered the microstructure codes, compared them to each other, and settled discrepancies via discussion. Then, all transcripts were checked a third time by the first author.

Alphabet knowledge. The ALL Letter Knowledge subtest was used to measure alphabet knowledge. Test items required participants to point to, name, and write various lower- and upper-case alphabet letters. The maximum raw score for this subtest was 30.

Phonological awareness. The Rhyme Knowledge, and Sound Categorization subtests of the ALL were administered to assess participants' phonological awareness. The Rhyme Knowledge subtest includes four types of tasks, which required participants to determine whether two words rhymed, decide which word out of a set of words did not rhyme, produce a rhyming word when given a prompt, and complete a sentence with an appropriate rhyming word. The last type of task contains different items for preschool and kindergarten students than for first grade students. However, in order to compare participants' performance on the same set of items, we administered the preschool and kindergarten items to all participants. Thus, the maximum possible score for the Rhyme Knowledge subtest was 20. In the Sound Categorization tasks, the participants were asked to indicate which word out of a set of words did not begin with the same sound (phoneme) as the other words. The maximum possible score for this subset was 16.

Print and book awareness. The Book Handling subtest of the ALL was used as a measure of print awareness. In this subtest, participants handled a real children's book and were asked to identify book and print conventions, such as the cover of the book, the title, and the direction that the eyes move when reading. The maximum raw score for this subtest was 8.

PROCEDURES

This study took place over 8 weeks during the summer of 2012. Individual pre- and post-testing was completed during Weeks 1 and 8. In Weeks 2–7, participants completed twelve, 40-min

sessions (two sessions per week) of CFLI or SNRI in small groups of two or three children. There were two small groups each for the CFLI and SNRI interventions. Each session was led by one graduate student clinician, assisted by an undergraduate student, and supervised by a Ph.D. faculty member. A total of four graduate students and two undergraduate assistants provided the interventions. To avoid possible effects of interventionists on the treatment outcomes, all interventionists were involved in the provision of both types of instruction. Each graduate student was responsible for leading one SNRI group and one CFLI group per week. Each of the undergraduate students assisted with two CFLI sessions and two SNRI sessions per week. All sessions were video and audio recorded for fidelity coding.

Book selection

All lessons for both CFLI and SNRI sessions were constructed with traditional children's picture books as the focus. Each session focused on a children's book selected as specifically appropriate for CFLI or SNRI interventions groups. SNRI books were true narratives, having characters, a setting, at least one problem, at least one attempt to solve the problem, and a resolution. (e.g., *Harry the Dirty Dog* by Zion, 1956). SNRI activities involved identification and discussion of these narrative components (i.e., story grammar components), explanations of advanced vocabulary, and practice retelling narratives. In contrast, CFLI books contained features that highlight sounds and print, such as use of rhymes, alliteration, onomatopoeia, and variable font sizes (e.g., *Chicka Chicka Boom Boom* by Martin and Archambault, 1989) and CFLI activities involved rhyming, wordplay, and letter-sound correspondence. A few storybooks fulfilled the requirements of each intervention type and were used in both groups and presented within the parameters of each condition (e.g., *Bear's Loose Tooth*, Wilson and Chapman, 2011). Regardless of the type of treatment condition being implemented, all sessions followed similar general routines. In each intervention, eight books were used for one session each, and two books were used for two sessions each. By the end of the intervention program, all participants had completed 12 lessons focused on 10 authentic children's books.

SNRI sessions

A sample lesson plan for the SNRI program is provided in Appendix A of the Supplemental Materials. At the beginning of each session, the clinicians introduced the book by reading the title and identifying the author and the illustrator and then leading a group discussion of the roles of the author (i.e., "to write the story") and the illustrator (i.e., "create the pictures"). As sessions progressed, the clinicians requested that the participants describe the jobs of the author and illustrator with appropriate scaffolding as needed. The clinicians also encouraged story predictions based on the title and cover illustrations.

As the clinicians read the book aloud, they engaged participants in think-alouds and discussions of the story during the reading. Clinicians drew attention to story grammar components (e.g., characters, setting, problem, attempts to solve the problem, resolution) as they arose during the story, and visual supports unique to each story were used to help children remember them. For example, clinicians would draw pictures on a white board to represent the various narrative components or use puppets or small toy figures to represent characters in the story. Clinicians also paused during readings to explain pre-identified "Tier 2" vocabulary words (cf. Beck et al., 2002) and provide participants opportunities to discuss and act out word definitions.

After reading the story, the clinicians led the group in reviewing each of the components of the narrative by asking questions such as, "Who were the characters in this story?" Clinicians were instructed to make sure every child had an opportunity to respond to at least one question during the story. As answers were provided, clinicians provided modeling, prompting, recasts and expansions to encourage more complex language use. Next, each participant took a turn to retell the story, with clinicians using visual supports and verbal prompts, as needed, to scaffold the retelling. The clinicians used recasts and expansions of the participants' productions to encourage more complete and grammatically complex retells. A sample transcript of a child's scaffolded retell is provided in Appendix B of the Supplemental Materials.

Each session ended with a brief art activity related to the story, and participants were encouraged to sign their art with their name. Clinicians provided instructions and support as needed to complete the art activity, and they were encouraged to facilitate further discussion of the story when possible. Participants received their own copy of the book at the end of each session, and they and were encouraged to re-read the book at home with their family.

CFLI sessions

A sample lesson plan for the CFLI group is provided in Appendix C of the Supplemental Materials. CFLI sessions began with the clinicians leading the "alphabet song" while pointing at each letter on a visually appealing alphabet board. Each day, two or three "letters of the day" and "sounds of the day" (which corresponded to the letters) were then introduced. The clinicians named the alphabet letter, modeled how to write it on a white marker board, and modeled the pronunciation of the sound(s) it represented. Each participant was then provided with an opportunity to write the letter, name it, and say its sound(s) with scaffolding as needed.

After introducing target letters and sounds, the clinicians introduced the storybook with the similar procedures to the SNRI introduction. Discussions of the author and illustrator and their roles was the same. Instead of making predictions about the story, participants' attention was drawn to the letters and words of the title. Participants were directed to look for the "letter of the day" and listen for the "sound of the day" throughout the book reading.

As the clinicians read the story aloud, they drew the participants' attention to print concepts and portions of the book that featured rhymes or other wordplay. Participants were encouraged to be "rhyme detectives" and "sound detectives" and raise their hands when they heard rhyming words or words that started with the sound of the day. Clinicians were instructed to make sure every child was called on to answer a question related to each target in each session.

After the story, participants completed activities and games to increase phonological awareness and phonics knowledge. Activities included sorting pictures of rhyming words, categorizing words according to their initial or final sounds, and blending and segmenting words with manipulatives (e.g., tokens, foam alphabet letters, etc.). Activities were selected and modified, and clinicians provided scaffolding as needed, according to individual participants' skill progression throughout the intervention. A brief art activity related to the story closed each session, and participants were encouraged to sign their art with their name. Participants took home the storybook at the end of each session and were encouraged to share the book at home with their family.

Intervention fidelity

Prior to the initiation of the study, the clinicians and assistants completed a one-day training that covered the goals of the intervention, the participant information, and specific procedural expectations. During the training, clinicians practiced implementing instructional strategies for each intervention, and the faculty supervisors provided instruction and feedback for implementing each of the different interventions. Emphasis was placed on the importance of not introducing skills intended to be targeted in one type of instructional group into the other group.

To measure the degree to which the interventions were implemented as intended, a fidelity assessment checklist was developed for each intervention. The checklists included ratings for the presence and frequency of occurrence of each component of the intervention for each child in the group (see Appendix D and E in supplementary materials). All intervention sessions were videotaped, and a trained research assistant who was not involved in any other aspect of the project completed fidelity checks from the videos for eight sessions for each group (33% of all sessions). Fidelity was moderately high for each intervention [CFLI = 0.85 (0.08); SNRI = 0.78 (0.12)]. A primary reason for loss of fidelity was time spent managing problem behaviors within the sessions, which necessarily detracted from time spent on intervention goals. Although the mean fidelity rating for CFLI was slightly higher than for SNRI, the fidelity difference between conditions was not statistically significant ($p > 0.2$).

DATA ANALYSIS

Because the small sample size in this study makes it difficult to determine whether the obtained data meet the necessary assumptions of parametric analyses, nonparametric tests were used. First, a series of Mann–Whitney *U*-tests were run to compare language, literacy, and cognitive abilities of the two treatment groups prior to the intervention. Analyses of the descriptive measures (i.e., Form Completion and Figure Ground subtests of Leiter and Basic Concepts and Parallel Sentence Production subtests of the ALL) focused on standardized test scores. However, raw scores were used as the unit of analysis for the target outcome measures, given that several measures were not norm-referenced and that norms for most of the ALL subtests were not available for all participants.

Next, gains between pre- and post-test were calculated for each group separately, using Wilcoxon Signed Rank tests. Given our small sample size and the goal of determining whether the experimental intervention should be pursued with a future larger-scale study, we were more concerned about falsely retaining the null hypothesis than falsely rejecting it (cf. Robey, 2004). Therefore, we set alpha for two-tailed significance tests at 0.10, and no adjustments were made for repeated measures. Effect sizes for group comparisons and treatment effects were calculated using Cohen's *r* using the Z statistic from the nonparametric test and the formula $r = Z\sqrt{N}$ (Fritz et al., 2012).

RESULTS

DESCRIPTIVE MEASURES

Table 1 provides descriptive statistics for chronological age and the background assessments of language and nonverbal cognitive ability for each group prior to the intervention. Mann–Whitney *U*-tests revealed no significant differences between groups on any of these measures. Based on effect sizes, the groups appeared to be well matched for chronological age and basic oral language, but somewhat less so for nonverbal cognitive ability.

TREATMENT EFFECTS FOR VOCABULARY, LISTENING COMPREHENSION, AND NARRATIVE SKILLS

Descriptive statistics for each group are provided in **Table 2** for the measures of vocabulary, listening comprehension, narrative macrostructure, and narrative microstructure. There were no significant group differences in pre-test scores for any measures, and effect sizes ranged from small to medium. Specifically, the between-group effect sizes for PPVT-4 ($U = 9$, $p = 0.80$, $r = 0.08$), ALL Listening Comprehension ($U = 8$, $p = 0.62$, $r = 0.08$), macrostructure score ($U = 8$, $p = 0.62$, $r = 0.16$), total number of words ($U = 9$, $p = 0.80$, $r = 0.08$), and number of different words ($U = 10$, $p = 1.00$, $r = 0$) ranged from nil to small, indicating that after the randomization of participants to groups and the attrition of one participant from the initial SNRI group, there were only small differences between groups on these measures at pretest. However, the between-group effect sizes for the grammatical complexity measures, MLU ($U = 5$, $p = 0.22$, $r = 0.41$) and clausal density ($U = 5$, $p = 0.22$, $r = 0.41$) were moderate, suggesting that the groups were less well matched on these measures at pre-test.

Table 1 | Background assessments of age, oral language, and nonverbal cognitive abilities.

	SNRI median (Range)	CFLI median (Range)	Sig. test *N* = 9	Effect size *(r)*
Chronological age (months)	58.5 (49–82)	56.0 (50–71)	$U = 9$ $p = 0.81$	0.08
ALL basic concepts (SS)	8.0 (4–10)	9.0 (4–11)	$U = 8$ $p = 0.62$	0.17
ALL parallel sentences (SS)	9.0 (7–10)	9.0 (6–10)	$U = 9$ $p = 0.80$	0.09
Leiter figure ground (SS)	11.5 (6–13)	9.0 (7–12)	$U = 6.5$ $p = 0.38$	0.29
Leiter form completion (SS)	10.5 (9–15)	10.0 (7–12)	$U = 7$ $p = 0.46$	0.25

Table 2 | Pre- and post-test assessments of vocabulary, listening comprehension, narrative macrostructure, and narrative microstructure

	SNRI group				CFLI group			
	Pre-test median (Range)	**Median gain (Range)**	**Post-pre sig. test $n = 4$**	**Effect size (r)**	**Pre-test median (Range)**	**Median gain (Range)**	**Post-pre sig. test $n = 5$**	**Effect size (r)**
PPVT-4	64.5 (54–99)	7.5 (4–14)	$Z = 1.83$ $p = 0.07$	0.92	65.0 (42–100)	3.0 (–6 to 19)	$Z = 1.10$ $p = 0.27$	0.49
ALL listening comprehension	11.5 (4–16)	0.5 (–1 to 3)	$Z = 0.82$ $p = 0.41$	0.41	9.0 (1–16)	3.0 (–1 to 7)	$Z = 1.63$ $p = 0.10$	0.73
Narrative macrostructure	10.5 (6–20)	9.5 (0–13)	$Z = 1.60$ $p = 0.11$	0.80	13.0 (2–19)	6.0 (3–10)	$Z = 2.03$ $p = 0.04$	0.91
Total number of words	91.5 (63–132)	43.5 (24–58)	$Z = 1.83$ $p = 0.07$	0.92	112.0 (30–118)	28.0 (–6 to 47)	$Z = 1.21$ $p = 0.23$	0.54
Number of different words	57.5 (41–73)	16.0 (6–28)	$Z = 1.83$ $p = 0.07$	0.92	66.0 (22–75)	13.0 (–6 to 26)	$Z = 1.22$ $p = 0.23$	0.54
Mean length of utterance	7.42 (5.12–8.00)	0.18 (0.17–1.05)	$Z = 1.84$ $p = 0.07$	0.92	5.89 (4.29–7.00)	1.68 (–2.52 to 2.24)	$Z = 0.67$ $p = 0.50$	0.30
Clausal density	1.56 (1.13–1.71)	0.01 (–0.15 to 0.27)	$Z = 0.37$ $p = 0.72$	0.18	1.33 (1.20–1.38)	0.26 (0.13–0.43)	$Z = 2.02$ $p = 0.04$	0.90

Also shown in **Table 2** are the significance tests and effect sizes for pre- to post-test comparisons for each group on each of these measures. The SNRI group showed large significant pre- to post-test gains on four of the seven measures, PPVT-4, number of total words, number of different words, and MLU ($r = 0.92$, $p = 0.07$ for all four measures); a large gain was also observed for the macrostructure measure, which was just above the criterion for significance ($r = 0.80$, $p = 0.11$). Non-significant gains were observed for the SNRI group for the ALL Listening Comprehension subtest and for clausal density, with medium ($r = 0.41$, $p = 0.41$) and small ($r = 0.18$, $p = 0.72$) effect sizes, respectively.

In comparison, the CFLI group showed significant improvement between pre- and post-test on two of the seven measures, narrative macrostructure and clausal density, with large effect sizes for both measures ($r = 0.90$ and 0.91, respectively, both $p = 0.04$), and a large and marginally significant gain for the ALL Listening Comprehension subtest ($r = 0.73$, $p = 0.10$). The CFLI group's effect sizes for the remaining four measures which showed non-significant gains (PPVT-4, total number of words, number of different words, and MLU) were in the moderate range ($r = 0.30$–0.54; $p = 0.23$–0.50) Overall, while both groups evidenced some gains, the SNRI group showed more statistically significant gains and more large effect sizes than the CFLI group. However, such results must be interpreted with caution, given the small sample sizes in the current study.

TREATMENT EFFECTS FOR ALPHABET KNOWLEDGE, PHONOLOGICAL AWARENESS, AND PRINT AND BOOK AWARENESS

Measures of code skills were also administered for comparison purposes. Each group's performance on pre-tests and post-tests of code skills is summarized in **Table 3**. At pretest, there were no significant differences between groups on any of the measures, and all of the effect sizes were small, indicating that the two groups were well matched initially: ALL Letter Knowledge ($U = 7.5$, $p = 0.54$, $r = 0.21$), ALL Rhyme Knowledge ($U = 9.0$, $p = 0.80$, $r = 0.16$), ALL Sound Categorization ($U = 9.0$, $p = 0.80$, $r = 0.08$), ALL Book Handling ($U = 9.0$, $p = 0.80$, $r = 0.08$).

Although the test scores for some children in each group increased between pre- and post-test, differences between scores at pre- vs. post-test were not statistically significant for any measure for either group. However, the CFLI group obtained a large and marginally significant effect size for the ALL Rhyme Knowledge subtest ($r = 0.71$, $p = 0.11$), and both groups obtained large and marginally significant gains for the ALL Book Handling subtests ($r = 0.80$ and 0.71 for SNRI and CFLI, respectively; both $p = 0.11$). Effect sizes for the ALL Letter Knowledge and the ALL Sound Categorization subtests were in the moderate range and non-significant for both groups ($r = 0.48$–0.67; $p = 0.18$–0.58).

DISCUSSION

Children from low-SES homes are known to be at risk for reading difficulties, including learning to decode words and learning to comprehend texts. Although there is a large body of research to guide instruction in decoding, there is less evidence to inform instruction in the skills that support reading comprehension, especially for very young children. Therefore, the purpose of this preliminary study was to determine if SNRI is feasible and if it shows the potential to improve meaning-related knowledge and skills in at-risk, preliterate children. Specifically, we aimed to investigate the influences of this previously untested intervention on children's vocabulary knowledge, narrative comprehension, and narrative production and to determine if outcomes were sufficiently positive to warrant further investigation. Prior to

Table 3 | Pre- and post-test assessments of alphabet knowledge, phonological awareness, and print concepts.

	SNRI group				CFLI group			
	Pre-test median (Range)	**Median gain (Range)**	**Post-pre sig. test $n = 4$**	**Effect size (r)**	**Pre-test median (Range)**	**Median gain (Range)**	**Post-pre sig. test $n = 5$**	**Effect size (r)**
ALL letter knowledge	26.0 (1–30)	0.5 (–2 to 7)	$Z = 0.55$ $p = 0.58$	0.28	22.0 (6–30)	0.0 (–2 to 5)	$Z = 1.07$ $p = 0.29$	0.48
ALL rhyme knowledge	4.5 (0–18)	2.5 (–3 to 5)	$Z = 1.10$ $p = 0.27$	0.55	3.0 (2–15)	1.0 (0–14)	$Z = 1.60$ $p = 0.11$	0.71
ALL sound categorization	4.0 (1–7)	0.5 (0–2)	$Z = 1.34$ $p = 0.18$	0.67	5.0 (0–7)	3.0 (–2 to 7)	$Z = 1.21$ $p = 0.23$	0.54
ALL book handling	3.0 (0–4)	2.0 (0–4)	$Z = 1.60$ $p = 0.11$	0.80	2.0 (2–5)	2.0 (0–6)	$Z = 1.60$ $p = 0.11$	0.71

initiating a large-scale randomized control trial, we also aimed to determine whether SNRI was feasible as designed and implemented as well as if modifications were needed to maximize treatment effects.

The participants were randomly assigned to receive either the experimental SNRI or the comparison CFLI in 40-min small-group sessions twice weekly for 6 weeks. Both intervention programs featured shared reading of authentic children's storybooks, with high amounts of interaction, though the topics of the interactions differed. Analysis of pre- and post-test measures of vocabulary knowledge, listening comprehension, narrative macrostructure, and narrative microstructure were administered to measure changes in meaning-related skills for each intervention group. In addition, measures of alphabet knowledge, phonological awareness, and book handling were also administered to measure changes in code skills.

TREATMENT EFFECTS ON MEANING RELATED SKILLS

The SNRI group showed significant improvement between pretest and posttest on four of the seven meaning-related measures. Moreover, the SNRI group evidenced very large effect sizes for gains on five of the seven measures, which represented all but one type of the meaning-related skills we assessed. Specifically, we observed effect sizes of $r = 0.80$ or greater for assessments of vocabulary (PPVT-4), narrative macrostructure, narrative length (total number of words), lexical diversity (number of different words), and grammatical complexity (MLU). We were somewhat surprised that the SNRI group did not show significant improvement in ALL Listening Comprehension scores, given that they showed substantial gains in narrative macrostructure scores between pre- and post-test. However, the items on the ALL Listening Comprehension test were scored dichotomously based on children's responses related to selected specific details from each story, whereas the macrostructure scoring rubric was more closely aligned with the instructional components of SNRI (i.e., elements of story grammar) and awarded partial credit scores. Thus, the macrostructure score may have been a more sensitive measure of response to SNRI instruction than the ALL Listening Comprehension score.

The CFLI group also showed significant improvement on two of the seven meaning-related measures, with effect sizes above $r = 0.7$ for three of the seven measures: ALL Listening Comprehension, narrative macrostructure and clausal density. Thus, while the SNRI group showed improvement on a larger number of assessments than the CFLI group, the CFLI group showed improvement on two of the measures that the SNRI group did not. From these results, we conclude that SNRI shows some potential for improving a range of meaning-related skills in young, preliterate children, but further study with a larger sample is needed to determine whether the observed gains are reliable and whether they are significantly larger than those that would be obtained from other interventions.

TREATMENT EFFECTS ON CODE SKILLS

The purpose of this study was to test an intervention that would support the development of children's oral and written language comprehension skills. However, we also included assessments of code skills, for comparison purposes and to measure the progress of the CFLI group on the targets of their intervention. Neither group made significant improvements on any of the code skill measures, although the CFLI group's gain for the ALL Rhyme Knowledge subtest was marginally significant with a large effect size. With the exception of the Book Handling subtest of the ALL, the effect sizes for pre- to post-test gains were generally in the moderate range. Both groups evidenced large and marginally significant effect sizes for gains on Book Handling. This result is not surprising, given that both interventions included an introduction to the day's storybook that involved discussion of the title, author, and illustrator. Overall, the two groups evidenced a similar pattern of results for code skills, with a slight edge for rhyme knowledge evidenced by the CFLI group. It remains to be determined whether such results would be replicated with a fully powered study.

EVALUATION OF INSTRUCTIONAL METHODS IN SNRI

This study builds on previous shared book reading interventions through the addition of explicit instruction on story grammar and focus on developing children's narrative macrostructure and

microstructure during narrative retellings. SNRI sessions, which lasted 40 min, were also more intensive than the most common shared book reading intervention, dialogic reading, which averaged 10 min (Lonigan and Whitehurst, 1998). Although the effects of SNRI appear positive, future research should conduct a cost-benefit analysis to determine whether the extra intensity and additional treatment targets result in substantially better outcomes.

Our use of authentic children's books was also a variation on the work of earlier narrative language interventions in which wordless picture books were used for narrative interventions (Hayward and Schneider, 2000; Swanson et al., 2005) or in which the researchers designed the narratives (Davies et al., 2004; Spencer and Slocum, 2010; Green and Klecan-Aker, 2012). The participants appeared to enjoy the instructional sessions and looked forward to receiving storybooks that they could take home. Moreover, the treatment effects on meaning-related skills were positive for SNRI suggesting that the possible variation introduced by authentic storybooks does not mitigate treatment effects.

All of the clinicians provided written feedback regarding their experiences with implementing SNRI. Several remarked that prior to the intervention, they expected that SNRI would be easy to implement because it involved naturally engaging children in book reading. However, they discovered that teaching the story grammar elements was less intuitive and required more practice than they initially projected. Whereas the targets of the CFLI instruction, such as recognizing and generating rhymes, were relatively concrete, some of the story grammar components, such as problem and attempts to solve it, were more abstract and more difficult to explain to young children. Some interventionists reported that their comfort level with implementing the intervention varied depending on the specific story that served as the focus for the lesson. Additionally, while the use of visual supports that were unique to each story initially seemed to offer the most flexibility, the clinicians suggested that future studies try using consistent visual supports across all sessions. Although such visual supports would likely be more abstract, their consistency might facilitate participants' generalization and retention of story grammar components.

The interventionists were occasionally required to manage behavior within some of the groups. Competing environmental noise and distractions within the childcare center (staff and/or children interrupting the treatment session) also interfered with instructional time. Although the frequency of these factors was similar across treatment groups, they were perceived as more disruptive to the SNRI sessions than the CFLI sessions, perhaps because the activities of the SNRI sessions were less concrete than those of the CFLI sessions. For example, during the portion of the session where CFLI participants played card games or completed worksheets to practice code skills, the SNRI participants were retelling narratives. Thus, the clinicians suggested that the addition of manipulatives and "hands-on" activities be considered for future SNRI sessions. While some aspects of the intervention could be improved, generally, all interventionists were quite complimentary of their experiences and expressed an interest in seeing the development and testing of SNRI continue.

LIMITATIONS

The current study has several limitations. First, the sample size was very small, which limited our statistical power for testing treatment effects and prevented us from using standard analyses to test for interactions between groups and treatment gains. To increase our power for detecting treatment effects, we used a more liberal critical alpha level ($p < 0.10$), which makes our findings more vulnerable to Type I error. Second, we did not have an untreated control group. Consequently, we cannot rule out the possibility that the both group's gains may have occurred due to normal maturation or simple practice effects. A third limitation is that it was not possible to conduct a longer-term delayed post-test to determine whether intervention effects were maintained. Given these limitations, the outcomes of this study should be interpreted with caution. However, the positive results we have observed support the undertaking of more rigorous experimental testing of the effectiveness of SNRI. Future studies should consider including a delayed posttest to determine if treatment gains observed immediately following treatment are maintained over a longer period.

CONCLUSIONS AND FUTURE DIRECTIONS

We aimed to determine the feasibility and potential effectiveness of SNRI for improving the comprehension-related skills of young, preliterate children from low SES backgrounds. The results of this study indicate that SNRI is feasible and shows promise of effectiveness. It builds on the findings of previous studies of shared book reading, which have primarily focused on vocabulary gains, as well as previous studies of narrative interventions, which have primarily focused on older school-aged children. This work is an initial step toward establishing evidence to address the paucity of data that exists regarding comprehension-related skills and examining narrative interventions among preschool and kindergarten children who are at-risk of reading failure. We conclude that future investigations on a larger scale are warranted, perhaps including modifications to enhance participants' success.

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SUPPLEMENTARY MATERIAL

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Intensive exposure to narrative in story books as a possibly effective treatment of social perspective-taking in schoolchildren with autism

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One of the major characteristics of autism is impairment of communication and socialization. While such impairment *per se* has been well documented, research into effective interventions for children with this developmental disorder is still limited. Here we present preliminary evidence for the possibility of improvement of the capability of social perspective-taking in schoolchildren with autism by having intensive experience with narrative, in which they were exposed to narrative in story books read by their parents over a consecutive 5- to 6-day-period. When their capability was evaluated on the basis of a conventional role-taking task, the mean score tended to increase after the exposure as compared to before the exposure, whereas such a change was not recorded in children who did not experience such exposure. These effects were confirmed when the children were retested 4 months later. Although preliminary, the current study represents a step toward the development of more effective social perspective-taking interventions for children with autism.

Keywords: autism, narrative, social perspective-taking, mental state, treatment

INTRODUCTION

Particular characteristics of childhood autism involve a profound impairment of communication and language, which is occasionally noticeable despite an adequate capacity for speech among the more intellectually able children with this disorder (Sigman and Capps, 1997; Howlin et al., 1999; American Psychiatric Association, 2013). Pioneering studies have revealed the fact that those children have characteristic difficulties with personal pronouns and with relative terms for time and space, i.e., with the use of deictic terms (see Baron-Cohen et al., 2000; Markram and Markram, 2010 for review). A speaker must be sensitive to a hearer's information needs in order to effectively communicate using such deictic terms, but even intellectually able adults with autism have difficulty achieving that, mainly due to impairment of the perspective-taking capability that is involved in the use of deictic terminology (Masataka, 2003).

Perspective-taking is an area of human functioning that entails a complex repertoire of linguistic and relational behavior. Cognitive and developmental psychologists commonly agree that the capability to take the perspective of another person greatly contributes to an individual's success in social situations, and involves a critical and complex set of skills (Barnes-Holmes et al., 2004). Perspective-taking involves inferring another person's desire and beliefs, in order to interpret their behavior and predict what they will do next (Sigman and Capps, 1997; Howlin et al., 1999). Common human activities that are believed to involve perspective-taking include deception, empathy, self-consciousness, self-reflection, persuasion, and pretence, as well as being essential for effective communication (Howlin et al., 1999).

Conceptually, perspective-taking can be classified into three levels, i.e., the perceptual level (comprehension of how others perceive the world one also perceives; Piaget and Inhelder, 1956), the cognitive level (comprehension of others' personal knowledge and belief; Frith, 2003) and the social level (comprehension of others' emotion and thought; Mar, 2004). Impairment in perspective-taking capability in children with autism involves each of these three levels (Reed and Peterson, 1990; Hamilton et al., 2009). Nevertheless, studies of autism conducted thus far have overwhelmingly concentrated on impairment at the cognitive level (typically known as the theory of mind problem, ToM). ToM is a term for a set of complex cognitive processes, enabled by a system of cognitive mechanisms, which result in "the ability to infer the mental state of others (e.g., their knowledge, intentions, beliefs, and desires)" (Ozonoff and Miller, 1995, p.417). Consequently, a great number of investigations on cognitive skill or ToM treatments have been conducted with children, particularly preschool children, with autism since the pioneering work by Ozonoff and Miller (1995), who attempted to develop perspective-taking in nine adolescents with autism in the context of a social skills training program. In the study, five of them in the treatment condition received specific instruction in perspective-taking strategies, while the remaining four (control group) received regular social skills training only. A variety of techniques were employed to teach perspective-taking skills, including role-play and video feedback. At the end of the experiment,

80% of the intervention group improved their ToM composite score, whereas only 25% of the control group did, but no effect was seen on parent or teacher ratings of participant social skills.

Further studies have also shown that children with autism can be taught to pass a ToM test said to be indicative of perspective-taking (e.g., Swettenham, 1996; Hadwin et al., 1997). Recently, some children with this disorder have participated in studies of the more basic component skill of perspective-taking (at the perceptual level; Heagle and Rehfeldt, 2006; Gould et al., 2011). Concerning social perspective-taking, however, there have been virtually no reports of such investigations, though understanding the thoughts, feelings and motivations of others is crucial to successful relationships. Moreover, although social perspective-taking is particularly important for children in the classroom, most research on intervention for children with autism has focused on the evaluation of its effects on preschool children. The general consensus among researchers is that social perspective-taking can influence many elements of the academic experience and that students who get higher grades also tend to be more motivated and more accurate in their perspective-taking as revealed by recent studies (McKenzie et al., 2010, 2011) that reported that adolescents with autism were substantially less influenced than neurotypical adolescents in their conditional reasoning by the presentation of contextual cues in the form of alternative and additional arguments. On the basis of this evidence, those authors hypothesized that the participants with autism were less likely to integrate relevant and available contextual knowledge into the reasoning process, which is closely associated with the ability of perspective-taking.

Here, we report the results of our preliminary attempts to provide brief social perspective-taking treatment consisting of telling original narratives in story books. Entertainment by looking at and listening to story books occurs ubiquitously in young children and their caregivers (Aram and Aviram, 2009). Children are considered to experience a variety of emotions through such opportunities, to acquire literacy skills as well as communication ability, and to cultivate imagery capability (Foorman and Torgesen, 2001; McGee and Morrow, 2005). A narrative is a depiction of events, which are driven by the intentional behaviors of agents with unique goals, in imagined settings that can parallel the real world (Mar, 2004). Understanding a narrative requires one to understand the intentions, goals, emotions as well as other mental state of characters, which is known as mentalizing (Frith and Frith, 2003). For narrative comprehension, one must take the perspective of a character and mentally represent his/her emotional state. This is the essential process of successful social perspective-taking.

Therefore, here we hypothesized that abundant experience with such narrative comprehension would enhance the capability of social perspective-taking in children with autism who show impairment in this cognitive aspect. We conducted the present treatment on the basis of the assumption that if children with autism come to achieve successful comprehension of more or less imagery sentences in story books through our treatment, their ability of processing the linguistic content will be enhanced to determine what is to be mentally imagined, and then the mental image can be evaluated and related to the sentence more properly by the children. Consequently, such experience would lead the children to enhance their capability of social perspective-taking. In fact, our findings provide suggestive evidence supporting the hypothesis that the ability to understand mental states of others could be improved by providing children with autism with opportunities to comprehend the activities of characters depicted in stories.

MATERIALS AND METHODS

This investigation was conducted according to the principles expressed in the Declaration of Helsinki. All experimental protocols were consistent with the Guide for Experimentation with Humans and were approved by the Institutional Ethics Committee of the Primate Research Institute, Kyoto University (#2011-150). We obtained written informed consent from the parents of all participants involved in our study.

PARTICIPANTS AND OVERALL DESIGN OF THE PRESENT STUDY

The participants consisted of 16 schoolchildren with autism and either of their mothers or fathers (14 mothers and two fathers). All of them spoke Japanese as their first language. The children had been diagnosed as such according to DSM-V (American Psychiatric Association, 2013) by psychiatrists from several facilities in Kyoto Prefecture, Japan. The general cognitive ability of the participants was assessed using Wechsler Intelligence Scale for Children (WISC III). The children were randomly classified into two groups, i.e., the group referred to as the Experimental Group below or that referred to as the Control Group below. Every child, whether classified into the Experimental Group or into the Control Group, was tested about his/her ability of perspective-taking twice in the 5- to 6-day-long experiment, i.e., at the beginning of the first day of the experiment and at the end of the final day of the experiment. During the experimental period, each child of the Experimental Group received intensive exposure to narrative as a treatment, but no such exposure was experienced by the children of the Control Group. Scores on an intelligence quotient (IQ) test, as well as the mean chronological age, did not differ significantly between the groups, as shown in **Table 1**.

PROCEDURE OF EXPOSURE TO NARRATIVE

For the treatment, we created a set of eight original story books in Japanese. The narrative of each of the eight was totally different from the others. However, each consisted of three episodes. The English version of the first episode of a representative narrative was as follows:

There was a boy named Taichi, who was attracted by creatures. One day, he found a frog on his way to school, caught it, and took it with him to school. After he entered his classroom, one of his classmates, Sayoko, came to him, and asked what Taichi had. Being flattered by her question, he showed her the frog. But she was scared of it, screamed, and started crying. Having heard the crying, their teacher appeared, and warned Taichi not to scare any friends and make them cry. Taichi was very depressed by what had happened. Returning back home, he visited a rice field to release his frog, and there he met another friend, Tamayo. She asked him what he had in his hands. Hearing that question, he really felt embarrassed.

Table 1 | Mean chronological ages (years: months) and mean WISC IQ scores of the participants.

	Group		Significance of difference (*P*)
	Experimental (*N* = 9)	Control (*N* = 7)	
Age	9:7 (1:0)	9:6 (1:5)	0.28
WISC III			
Verbal IQ	106.2 (16.2)	108.6 (20.7)	0.26
Performance IQ	100.3 (17.7)	105.1 (12.6)	0.14
Full-scale IQ	103.9 (17.7)	107.6 (17.2)	0.92

Standard deviations presented in parentheses. Probabilities were evaluated by t-tests (df = 14).

Each time the parent finished telling the first episode of a narrative, he/she was instructed to ask his/her child some questions concerning the mental states of the characters depicted in the episode, and some example questions were actually suggested.

With regard to the representative story mentioned above, they were:

(1) *Why was Taichi embarrassed by Tamayo's question?*
(2) *If Taichi shows the frog to Tamayo, how will she respond to it?*
(3) *If Taichi had talked with Sayoko about the frog instead of suddenly showing it to her, what do you expect would have happened with the two of them? I am wondering if you can guess how both of them would have felt.*

These questions were open-ended and had many possible proper answers. Parents were told to praise their children no matter how they responded to the questions. Following these questions, the second episode, which was as follows, was related:

One day, when Sayoko entered the classroom, her classmate Taichi had something in his hands. She got interested in what he had, and asked him to open his hands. When she saw what he showed, she was very scared of the frog, and cried because she was scared of it. However, she felt sorry for Taichi when he was scolded by the teacher and looked depressed.

While the first episode was told from the viewpoint of *Taichi*, the second one was apparently told from the viewpoint of *Sayoko*.

Having finished reading the second episode, the parents continued by reading the final one after a brief break. This episode was as follows:

Taichi told Tamayo that there was a frog in his hand, and asked whether she loved or hated frogs. Having confirmed that she loved frogs, he showed the frog to her. They played with the frog for a while and released it in a rice field. There, Sayoko came out, and apologized to Taichi about the frog. Taichi forgave Sayoko and they went home together.

Obviously this episode was prepared as an "answer" to the final question of the three the parents asked after telling the first episode. Parents of the participants were asked to read some of the narrative to the participant every day for a roughly 30-min period any time in the day during a 5- to 6-day period in August. Note that the treatment actually lasted only these 5–6 days.

They were given standardized instructions which were as follows: The purpose is to have your child imagine various perspectives and emotions of characters which are depicted in the narrative. Depending on the ability and motivation of your child, you may read to a child, or the child herself/himself may read aloud/silently. The narrative also includes several questions you should ask to your child. You are allowed to converse with your child about impressions about the narrative. If your child unavoidably loses her/his concentration, you need not force him/her to keep reading, but should try again at some other time.

During the experimental period, each parent was asked to keep detailed records about their practice of the exposure to narrative so that we could confirm that the treatment was really undertaken every day.

ASSESSMENT OF THE ABILITY OF PERSPECTIVE-TAKING

Just before the onset of the experiment and upon the completion of the entire experiment, each participant of the Experimental Group was assessed with respect to their competence of perspective-taking (perceptually, cognitively, as well as socially). The same assessment was also made twice for the participants of the Control Group, with the same interval between assessments as that for the participants of the Experimental Group. However, no exposure was conducted during the interval.

The assessment consisted of three tasks to investigate capability of perspective-taking: perceptual, cognitive and social perspective-taking tasks. The capability of perspective-taking at the perceptual level was evaluated on the basis of the three-mountain-task (Piaget and Inhelder, 1956). We prepared four photographs of three blocks, different in shape and colors, which changed in appearance depending on the viewer's perspective. The Experimenter presented one of the photographs on a personal computer, and asked children to guess how others would see it from their viewpoint, and to choose the proper one from the other three photographs by pointing to it. Children were asked twice about the appearance of the right and left side, and when they correctly answered both times, they considered to have passed the task.

The capability of perspective-taking at the cognitive level was evaluated on the basis of the false belief task (secondary level, Perner and Wimmer, 1985). Perner and Wimmer's (1985) second-order false belief test requires recursive understanding of one story character's belief about another's belief. Four pictures were presented on a personal computer screen. The Experimenter read aloud the task and asked the children to answer three questions. The first was a question regarding the secondary level of false belief: Where the boy thought the girl thought that the toy was? The two probe questions followed: where the toy actually was, and where the toy was put by the girl at first. Children who correctly answered all three questions were regarded to have passed the task.

For each task, the performance was given a score of points ranging from 0 to 1 for each individual. Children received a "1" if they passed the task and a "0" if they failed the task. On the basis of this score, the average value was computed both for the

Experimental Group and for the Control Group before and after the treatment.

Regarding social perspective-taking, the capability of each child was evaluated using a Japanese version of a role-taking task originally developed by Selman (1980). Each of the items of the task consists of a set of drawings and narrative. The English version of a representative narrative is as follows (each number corresponds to one of several different drawings that are to be presented simultaneously):

(1) *Once upon a time, there was a girl named Junko, who was good at climbing trees. One day, though she tried to climb down a tree, Junko failed to do so and fell down to the ground.*
(2) *Her father happened to watch it and scolded her so that Junko was forced to promise that she would never climb any tree.*
(3) *A few days later, it was found that a cat kept by Junko's neighbor, Taro, had climbed up the tree, and remained there helplessly. But Taro was poor at climbing trees, and asked Junko to help his cat.*
(4) *Unfortunately, no one was around there, and the only person who could help the cat was Junko, who was good at climbing trees. She was embarrassed by remembering her promise made to her father a few days earlier.*

After the narrative, the participant was asked to answer the following questions verbally:

(1) *Why was Junko embarrassed?*
(2) *If Junko decides to climb up the tree to help the cat, what do you expect her father to do?*
(3) *What is the reason for his response?*
(4) *What do you expect regarding the future of the cat if Junko and her father discuss the cat?*

All the answers given by all the participants were tape-recorded and transcribed later. These verbal responses were rated by two experimenters, independently, into one of three categories, reflecting three assumed levels of role-taking ability: 1 (differentiated and subjective perspective-taking: concepts of persons are differentiated, but concepts of relations stay subjective), 2 (self-reflective/second-person and reciprocal perspective: one can take a self-reflective or second-person perspective, and consider concepts of reciprocal relationship of self and another), and 3 (third-person and mutual perspective-taking: one can take a third-person perspective, and consider simultaneous and mutual coordination of self and others). When the rates' scores were different from one another between the raters, they discussed it and decided on the final score. Thereafter, the scores for each of the four questions were averaged for the first measurement and for the second measurement, and the mean value was computed for each measurement in the Experimental and in the Control Groups.

RESULTS

On the basis of the parental records, it was found that each participant child in the Experimental Group experienced the exposure to the narrative in a total of 10.4 times on average over the treatment period. As noted above, the purpose of the present study was to evaluate the effects of these experiences upon the capability of social perspective-taking in the schoolchildren with autism, using a conventional role-taking task. Actual transcriptions of all of the participants' answers to question 4 of the role-taking task (Selman, 1980) in the first and the second measurements that is documented in METHODS are shown in **Table 2**. As found there, noticeable changes in the answer between the first and the second measurements were seen in four of the nine children in the Experimental Group, whereas similar changes occurred in one of the seven children in the Control Group. Indeed, concerning these four children in the Experimental Group and one child in the Control Group, the overall score did show elevation from 1 (differentiated and subjective perspective-taking: concepts of persons are differentiated, however, concepts of relations stay subjective) to 2 (self-reflective/second-person and reciprocal perspective: one can take self-reflective or second-person perspective, and consider concepts of reciprocal relationship of self and another), or from 2 to 3 (third-person and mutual perspective-taking: one can take third-person perspective, and consider simultaneous and mutual coordination of self and others), whereas no such elevation of the score was recorded for any other participant. One child of the Control Group even showed a decrease of the score from 3 to 2.

In all, among the nine children of the Experimental Group, the number of the children who showed the elevation of the score was 4 whereas that of the Control Group was 1. The number of children who did not show any change was 5 in both of the groups. None of the children showed a decrease of the score in the Experimental Groups whereas one child of the Control Group showed such decrease. When within-group changes were evaluated on the basis of these results, using Sign tests, the increase of the overall rated scores of the role-taking task tended to be significant ($p = 0.063$) for the participants of the Experimental Group, but not for those of the Control Group ($p = 0.75$).

With regard to the three-mountain task (Piaget and Inhelder, 1956), on the other hand, mean scores (SDs) at the first measurement were 1.00 (0.00) for the Experimental Group and 0.86 (0.38) for the Control Group. The difference of the scores between the groups was not statistically significant ($p = 0.35$). At the second measurement, mean scores (SDs) were 0.89 (0.34) for the Experimental Group and 1.00 (0.00) for the Control Group. The difference between them was not significant ($p = 0.36$), either. With regard to the false belief task (Perner and Wimmer, 1985), mean scores (SDs) at the first measurement were 0.78 (0.45) for the Experimental Group and 0.58 (0.54) for the Control Group. The difference between the scores was not statistically significant ($p = 0.68$). At the second measurement, mean scores (SDs) were 0.67 (0.50) for the Experimental Group and 0.72 (0.49) for the Control Group. Again, the difference was not significant ($p = 0.36$).

We also evaluated the ability of social perspective-taking of all the participants except one child in the Experimental Group once again at 40 days after the testing that was performed immediately after the intense treatment, using the same inventory. As shown in **Table 3**, however, their scores did not exhibit substantial changes, indicating the long-term stability of the changes evoked by the treatment.

DISCUSSION

The finding of the present experiment that the average rating score was increased between the first and second measurements

Table 2 | Comparisons of transcriptions of the verbal responses between the first and the second measurements that were recorded to the question "*How do you expect the story of the cat to turn out if Junko and her father discuss the cat?* " which was asked in the inventory of social perspective-taking.

Group	Participant code	1st	2nd
Experimental	A*	Junko will climb up the tree.	The cat will helped by Junko.
	B*	The cat will be helped by Junko.	I think she should not climb up because it is dangerous.
	C	The cat will be helped by a fire truck equipped with a ladder.	Her father will permit Junko to help the cat if she takes adequate care.
	D*	Junko should have climbed with the help of a ladder.	Her father will help the cat with the use of a ladder.
	E	Having no other option, Junko will climb up the tree.	Her father will permit Junko to climb up the tree and take the cat down.
	F	Her father will bring a ladder, climb on it, and help the cat.	Her father will ask someone to bring a ladder, climb on it and help the cat.
	G	They will discuss the way to help the cat.	The cat should have been saved. Maybe her father will be able to climb.
	H	Her father helped the cat!	Her father will attempt to help the cat, maybe, by climbing on something like a ladder.
	I*	I think the cat will possibly be helped because Junko will climb up the tree.	I think the cat will be helped by Junko's climbing up the tree.
Control	J	Junko will climb up the tree, and her father will keep watching her actions.	The cat will be helped by Junko.
	K	Her father will climb up the tree.	Junko will warn the cat about its action, and ask her father for permission to climb up to it.
	L	I believe her father will permit Junko to climb. Otherwise, he will climb up by himself.	I think Junko would help the cat.
	M+	I think her father will call for a fire truck.	Her father will change his mind and permit calling for a fire truck.
	N*	Junko will be permitted to climb up the tree.	As she promised her father, helping the cat will be OK.
	O	Her father will allow her to help the cat.	The cat will be OK because Junko will help it.
	P	Her father will bring a ladder and help the cat.	Her father will bring a ladder and help the cat.

Asterisk denotes participants whose scores increased at the second testing, + denotes participant whose scores decreased at the second testing.

only by the role-taking task (Selman, 1980), which measures the performance of social perspective-taking, exclusively in those participants who experienced exposure to narrative indicates the effectiveness of this exposure as a treatment to promote such ability. The stability of the change of the performance was also confirmed by the results of retesting which was performed 4 months later.

Obviously, the cognitive process underlying narrative comprehension is a complicated one. First, it requires one to understand intensions, goals, emotions, and some other variable mental states of the characters (Gernbacher et al., 1992; de Vega et al., 1996; Komeda and Kusumi, 2006). If narrative comprehension involves social cognitive processes, then we would expect individuals who frequently engage with narratives to benefit socially in some way from these repeated experiences. Namely, with the exposure to narrative, one needs to take the perspective of a character and to mentally represent his or her emotional state to understand the behavior of the character, while social perspective-taking involves the capability of adopting and understanding the perspective of others, on the basis of which one empathizes with their experience and reactions (Davis, 1983; Blair, 2005). A recent study (Mar et al., 2006) indeed demonstrated that lifetime exposure to narrative fiction, controlling for exposure to expository non-fiction, is positively associated with social abilities, though the correlational nature of that study excludes the possibility of any causal inference. Subsequently, additional evidence was presented supporting the notion that there is a positive relation between exposure to story books and social development in preschool children (Aram and Aviram, 2009; Mar et al., 2010).

The present attempt to provide intensive exposure of schoolchildren with autism to narrative was conceived in order to pursue this issue further, and to apply such previous findings

Table 3 | Comparisons of transcriptions of the verbal responses between the first and the third measurements that were recorded to the question "*How do you expect the story of the cat to turn out if Junko and her father discuss the cat?* " which was asked in the inventory of social perspective-taking.

Group	Participant code	1st	3rd
Experimental	A*	Junko will climb up the tree.	Junko had permission from her father to climb the tree.
	B	The cat will be helped by Junko.	–
	C*	The cat will be helped by a fire truck equipped with a ladder.	I believe her father will permit Junko to climb. Otherwise, he will call for a fire truck.
	D*	Junko should have climbed with the help of a ladder.	Her father will help the cat with a ladder.
	E	Having no other option, Junko will climb up the tree.	Having no other option, her father will allow her to climb the tree.
	F	Her father will bring a ladder, climb on it, and help the cat.	Her father will bring a ladder and help the cat.
	G*	They will discuss the way to help the cat.	Her father will help the cat.
	H	Her father helped the cat!	Her father will help the cat somehow.
	I*	I think the cat will possibly be helped because Junko will climb up the tree.	Junko will climb the tree and help the cat.
Control	J	Junko will climb up the tree, and her father will keep watching her actions.	Junko will be permitted to climb up the tree just for once.
	K+	Her father will climb up the tree.	Junko will be permitted to climb up the tree with grown-up.
	L*	I believe her father will permit Junko to climb. Otherwise, he will climb up by himself.	Junko may be permitted to climb up the tree. If she couldn't, then call a friend who is good at climbing.
	M	I think her father will call for a fire truck.	Junko call for a fire truck or a neighbor, or wait for the cat climb down, or encourage it.
	N	Junko will be permitted to climb up the tree.	–
	O	Her father will allow her to help the cat.	The cat will be helped. Junko will talk her father that she wants to help the cat which cannot get down. Then he will allow her to climb the tree and she will climb to help it.
	P	Her father will bring a ladder and help the cat.	I think that her father will bring a ladder and make it through.

Asterisk denotes participants whose scores increased at the third testing, + denotes participant whose scores decreased at the third testing.

for the actual treatment for those children. In fact, the present findings suggest the possibility that in order to cultivate competence in social perspective-taking, intensive experience with story-telling over a period of some length would be effective. As an actual protocol of the intervention, moreover, importance of some open-ended questions the parents were instructed to ask each time they finished telling an episode should also not be dismissed. Because their performance of story-telling *per se* is likely to merely provide their children with opportunities to attend to a series of behaviors of characters depicted there, those questions could more actively solicit the children to understand the thoughts feelings and motivation of the characters.

Traditionally, the visuospatial system has been viewed as an intact area in people with autism, as represented by the phrase, "they are thinking in pictures much of the time" (Grandin, 1995). Typically, they perform better on a picture-word completion task than on a word–word completion task, suggesting an advantage of visual images over linguistic representation in access to semantics in autism. Recently, such a phenomenon has been explained in terms of an underlying neurological under connectivity among cortical areas in autism (Just et al., 2004), which could negatively impact or slow integration or communication among cortical regions involved in language and visual imagery processing. This explanation attributes many of the wide-spread abnormalities in psychological functioning in autism to an impairment in the coordination and communication between key brain processing centers. One of the main predictions made based on this explanation is that any facet of psychological and neurological function

that is dependent on the coordination or integration of brain regions is susceptible to disruption in autism. That is particularly the case when the computational demand of the coordination is large, and social perspective-taking is no doubt included among such cases. The acknowledgment of the important role of visual thinking has led to the common use of treatment methods that are based on picture exchange communication (Bondy and Frost, 1998) or visual organizers such as the TEACCH method (Schopler et al., 1998). On the other hand, verbal communication has continued to be primarily limited to the expression of instrumental functions, or simple labeling. Consequently, the capability of social perspective-taking in people with autism has remained underdeveloped. In this regard, we hypothesize that what is necessary for effective treatment of this capability is to provide such people with opportunities to rely on visualization to support their comprehension of the thoughts, feelings and motivations of others that are represented by language. The present findings suggest that intensive exposure to narrative should be an effective method to accomplish that, and lead to the above hypothesis, which is worth testing with a broader sample size than that investigated here. If it is really confirmed, exposure to narrative would be expected to be a particularly convenient method of treatment for children with autism, possible by enhancing cortical connectivity, which is characteristically decreased in children with autism.

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