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Parent–child interactions during traditional and computer storybook reading for children's comprehension: Implications for electronic storybook design

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ABSTRACT

The purpose of this study was to examine how parents and children interact during traditional and computer storybook reading in their home. Thirty-nine, 4-year old children read both a traditional and a computer storybook with a parent. Parent responsiveness and child verbalizations were coded during each type of book reading experience (traditional vs. computer). Parents' interactions during traditional and computer storybooks were similar for many variables but differed on overall parent engagement in favor of computer storybooks. Children's story comprehension scores were not significantly different between the two types of storybooks. For both kinds of storybooks, child attention, child language, and parent engagement were significant predictors of story comprehension. Our results suggest that a storybook is a storybook, whether the story is presented on paper or electronically, although the ways in which parents and children engage with the storybooks may differ as a function of the platform.

Q2 Recent nationally representative survey data of children ages 0–8 found that most young children (60%) read or are read to on a daily basis for approximately 30 min per day [1], an essential activity for creating a literate nation [2]. Despite the increase in families who own a computer, tablet, or smartphone in recent years, ebook reading is still less common with young children than traditional book reading [1]. In particular, recent data suggest that only 28% of children ages 8 and under have ever been read books on an ereader or tablet device [1], but these findings do not include children's use of ebooks on a desktop or laptop computer. Despite the slow increase in children's ebook reading, companies are dedicated to creating ebook content for young audiences. Considering the potential for children to download and read or to have books read to them on some kind of electronic device, it is important to understand how parents and children may interact differently when reading storybooks on electronic devices versus traditional storybooks.

The purpose of this study was to describe parent and child interactions during traditional and computer storybook reading with particular interest in how parent–child story-related conversation and engagement with both types of storybooks predicts story comprehension. Because very little data are available on the ways in which parents read traditional and computer storybooks to their children, our research question was: How do parents and children behave and engage with one another while reading computer and traditional storybooks?

Because parents vary their interactions based on the context of the interaction [3] and the computer skills of their children [4] and because the story narrative largely drives comprehension [5], we hypothesized that:

H1: Parents will be more interactive and engaged with their children during a computer storybook than with a traditional storybook as a result of the novelty of the platform and the interactive nature and prompts provided by the device.

H2: Parents will vary their interaction styles when engaging with a traditional and a computer storybook.

H3: Children will vary their verbal interactions when being read a traditional and computer storybook.

H4: Story comprehension will be influenced by the child's attention to the story and by children's prior verbal comprehension skills, as well as by their parent's interactions with them during storybook reading.

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1. Vygotsky's theory and media

Vygotsky's [6] sociocultural theory focuses on the importance of language and social interactions on child cognitive development and learning. According to Vygotskian theory, the expertise brought by mature members of a society, in this instance the parents, assists the child in using and understanding cultural tools such as language and media that transmit knowledge. It is through these interactions with a parent, that a child learns about his social world and is able to expand his cognitive skills and knowledge. According to Vygotsky, optimal learning occurs when children are engaged in interactions or experiences that are challenging, but manageable and still within their zone proximal of development (ZPD). The ZPD was defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" [6, p. 86]. This zone of proximal development continues to change and develop with the child. Therefore, as children's cognitive capacities improve, parent–child interaction should become more complex to ensure that the child is continually asked to master new skills, thereby advancing cognition and learning.

Beyond the role of the parent, Vygotskian theory [6] discusses the important role of tools and tool use on development. Vygotsky [6] explains that a tool is something that can be used in the service of something else. In this sense, media are both tools and signs that can mediate cultural knowledge acquisition. That is, it is possible that the child may also be influenced or supported by their interactions with the digital media itself, especially if the device or tool is interactive and responsive to the child's input and needs. If the device or technology adapts language to respond and interact with the child in ways that are both challenging but still within the child's ZPD, the interaction between the device and the child may resemble the interaction between the parent and child. Therefore, based on Vygotskian theory, we explore how parents and children interact with each other and with traditional and computer storybooks at home and focus on the types of interactions parents use to help their children learn plot-relevant, central story content.

2. Reading in the digital age

Young children are avid media consumers [7,1,8]. In this rapidly changing 21st century media environment, 53% of 2–4 year olds and 90% of 5- to 8-year olds have used a computer at some point, with children beginning to use a computer at 3.5 years [7]. Parents value computers; nearly 70% of the parents of 6-month to 6-year-old US children reported that computers helped their young children's learning [9].

Parents also consistently view books and reading positively [9] and research confirms the thesis that parent–child book reading supports literacy skills [2,10]. However, comprehension of content has been shown to vary as a function of format, with children learning more from traditional books than electronic books [11,12]. With so much time spent using traditional and emerging media platforms, it is timely to consider what kinds of family interactions occur during these types of media experiences in the home, especially the role that parent–child interactions play in children's story comprehension.

The demands of the media platform likely influence how or whether parents co-engage with their child during reading experiences, and thus how much they may interact with their child during those experiences. Since most preschoolers cannot read, parents understand that they must read a traditional book in order for the child to comprehend the content. Similarly, using a computer may be challenging for young children because the user must operate the mouse and keyboard in order to manipulate and move through the computer storybook [4], though new touchscreen tablet interfaces are simplifying that experience. While in some instances the computer may read the story to the child, in many instances the words are just presented for the child or adult to read in the same way they appear in a traditional storybook, thus requiring parental participation for pre-reading children in ways that are similar to a traditional storybooks.

Parent and child interactions during traditional book reading. Research on parent–child interaction during joint book reading provides evidence that interaction during book reading complements children's cognitive skill development. For example, Reese and Cox [13] found that parents' interactions with preschool-aged children during joint book reading were positively associated with vocabulary development and literacy skills. Moreover, mothers' warmth, perspective taking, and communication during book reading were associated with the child's level of socio-emotional development [14].

Although specific parent–child interaction characteristics like warmth are associated with socio-emotional development and academic skills, parent–child interactions do vary across different situations [3]. When reading storybooks to their preschool-aged children, for instance, only 50% of the mothers used the same strategies when reading familiar and unfamiliar books [15].

Consistent with Vygotskian theory [6], parents also adjust their interactions depending on the age and abilities of the child to remain in the ZPD. As children age, the type and amount of information provided by the parent changes during book reading [16]. Studies with preschoolers also demonstrate that parents adjust their verbal demands to meet the communication abilities of their children [17]. Taken together, these findings suggest that during book reading, parents adjust their interactions based on the child's age and developmental needs as well as the specific media content or context of the interaction.

Parent and child interactions during computer use. With children using new technology and the Internet more than ever before [7,1], researchers have begun to examine the ways in which children interact with the computer device directly or with other people via online interactions like Skype (e.g., [18,19]). Research on children's interactions during computer use indicates that the type of computer interface influences the child's engagement with adults on the computer. For example, research demonstrates that when children engage with *Family Story Play*, an online system that allows family members to read storybooks over the Internet to a child, children are more engaged and have higher quality interactions with the online reader when compared to a traditional Skype interaction session [18]. Studies have also shown that increasing the activities available during the online interaction, such as providing opportunities for the child to see themselves in an online storybook [20] or providing opportunities for photos to be sent between the users [19], can increase children's involvement in the online interactions.

Research on patterns of early computer use have found that children shift from using a computer while sitting on a parent's lap at around 2.5 years of age to using a computer independently at approximately 3.5 years of age [21,1]. While children may sit independently while using the computer, parents remain involved and regularly co-use the device with their young children [22]. Specifically, 40% of parents of children between 2- and 5-years old co-use the computer "all or most" of the time their child uses the computer [22].

Given that parents are still co-using computers with young children, another line of research has begun to examine parents' verbal interactions during computer co-use (e.g., Krcmar and Cingel, 2013; [23]). For example, children can interact with their parents

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while co-using the technology together in potentially similar ways to how they interact when jointly playing a game or reading a traditional storybook (e.g., [24]). Alternatively, parents may interact differently when using computer storybooks compared to other activities. Evidence suggests that parents alter their verbal interactions with their preschoolers when reading a computer storybook based on the child's executive functioning abilities and the child's control of the mouse [4]. Specifically, for those children who were actively using a mouse interface, parents spent more time discussing the mechanics of the device, such as clicking and moving the mouse. By contrast, parents focused on the story content for those children who were not actively using the mouse [4]. Other research has since reported similar findings indicating that parents interact in different ways with electronic books as compared to print books, with the primary difference focusing on the language related to "book features" [25,12]. It appears that parents engage in more conversation about book features when reading electronic books compared to print books, perhaps because reading an electronic book may be a more novel experience for the young child [25], and requires them to perform both motor and cognitive skills during the task [4]. Few studies, however, have directly examined both parent and children's verbal interactions during their co-reading experiences on computers. Therefore this study provides initial data about the ways in which children interact with parents during both traditional and computer storybook reading.

3. Method

3.1. Participants

Children were originally recruited as infants to participate in studies by placing advertisements in local newspapers in the Washington, DC metropolitan area, through commercial mailing lists, and through word-of-mouth advertising. If the parent granted permission, the infant then became eligible to be contacted for study participation. All children in this study had previously participated in other research projects conducted by the research lab when they were infants (e.g., [26]), but no data from prior studies was used for this current study.

Thirty-nine children (20 males, 19 females) between the ages of 4 and 4.5 years ($M = 4.25$, $SD = 0.09$) and their parent(s) participated in this study. Only one caregiver participated during each media presentation. If more than one parent was present, the parents decided which one was going to participate. The vast majority of the participating parents were mothers for traditional storybook (87%) and for computer storybook (82%). The children were predominately Caucasian (82%), as well as, African American (3.0%), Asian (3%), Latino (3.0%), and mixed races (10%). Twenty-eight percent of the parents had post college degrees, 69% had only college degrees, and 3% had only high school degrees.

3.2. Study design

Children were visited in their homes and tested under semi-naturalistic conditions. As part of a larger study, each child was visited on four days [26]. This was a within-subjects design in which each parent–child dyad participated with both the traditional and computer storybook, with the order of exposure for reading different storybooks counter-balanced. All participants read the computer storybook on a laptop computer that was provided by the experimenters. All children were videotaped during the session and coding of each measure occurred later after each child has completed the entire set of visits.

3.3. Materials and measures

The traditional and online storybooks. Two stories written for 3- to 5-year-old children were used in this study: a traditional storybook: *Click-Clack Moo: Cows That Type* by Doreen Cronin & Betsy Lewin, and a computer storybook: *Elmo Goes to the Doctor* [27]. For both storybooks, the parent read the story content to the child. *Click-Clack Moo: Cows That Type* is a 32-page traditional storybook about a farmer whose farm animals demand electric blankets to keep them warm in the barn. When the farmer refuses to meet their demands, the cows refuse to provide milk for the farmer. A neutral duck acts as the middleman between the cows and the farmer, until both the farmer and the farm animals find an appropriate compromise.

Elmo Goes to the Doctor is an online computer storybook that requires an adult to read the words to the child. The story is about Elmo's trip to the doctor. Elmo visits the doctor because he is not feeling well and sees many of his other friends at the doctor's office. Throughout the computer story, different items are interactive and can be explored by the child or parent clicking the object with the mouse. For example, at one point, a child or parent can click each character in the waiting room to see why each one is at the doctor's office.

Both *Click Clack Moo: Cows That Type* and *Elmo Goes to the Doctor* were relatively novel books at the time of the study. Most parents reported that they were either "not at all" or only "a little bit" familiar with the book *Click Clack Moo* (62%) and the computer storybook *Elmo Goes to the Doctor* (90%). Using a scale that had been previously developed for preschool-aged children (see [28]), children in the current study were asked to report how much they liked each storybook using a 3-point Likert scale from (1) "not at all" to (3) "a whole lot". A paired-samples t-test indicated no difference in children's report of liking the two storybooks; children's scores averaged 2.82 ($SD = 0.46$) for the traditional storybook and 2.82 ($SD = 0.46$) for the online storybook.

Language measure. The *Peabody Picture Vocabulary Test* (PPVT-III, [29]) is a non-verbal multiple-choice test that assesses receptive vocabulary. It is age-normed on a nationally representative sample where a percentile rank score is obtained. It consists of 175 pages with four pictures on each page, with each page arranged in increasing order of difficulty. In the test, children were given a word and asked to point to the corresponding picture. Internal consistency of this normed and validated measure ranges from 0.92 to 0.95 and concurrent validity ranges from 0.63 to 0.92 [29].

Story comprehension measure. Following procedures developed by Calvert and colleagues [28], a small group of researchers read and interacted with each type of storybook and generated questions about each story plot. Research assistants and college students then rated each question as being central, plot-relevant, or as incidental, plot-irrelevant material. Each question with a minimum centrality rating of 70% was retained. This procedure yielded 10 central questions for each program, which were made into multiple-choice questions to assess the child's comprehension of the two stories. A sample question from the *Click Clack Moo* storybook is as follows: "What do the cows use to write their message to Farmer Brown? (a) an ink pen; (b) a stick in the mud; (c) a typewriter. A sample question from the *Elmo Goes to the Doctor* storybook is as follows: "Where does Elmo go when he leaves the doctor's office? (a) to his friend's house; (b) school; (c) home.

Visual attention. All children were videotaped as their parents read them the storybooks. Attention was coded as the percentage of time the child spent looking at the screen for the computer and the book pages for the traditional storybook (see [30–32]).

Parent questionnaire and media diary. All parents were asked to complete a brief paper and pencil questionnaire about their

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family's media use. Parents were asked how much time is spent using computers or reading books, on a typical weekday and a typical weekend day in their household. Next parents were asked whether their child used various technologies, such as computers, and the age at which the child first used the technology. Parents also completed a media diary in which they selected one day and reported all of the media activities that the child did that day. Most parents (77%) completed the questionnaire and media diary.

Parent–child interactions. All parent–child dyads were videotaped as they participated with the traditional and computer books. From the videos, experimenters transcribed all verbal interactions that occurred during the media exposure, examining patterns such as parental scaffolding of the story that might lead to better learning (e.g., [6]).

3.4. Procedure

The procedure involved four separate visits to the child's home. At the initial visit, the study was described to the parent and informed consent was obtained. Parents also completed a questionnaire regarding demographic information such as their occupation, ethnicity, and educational attainment. Each child completed the Peabody Picture Vocabulary Test (PPVT) on one day, read the traditional storybook on another day, and completed the computer storybook on a third day. The days for reading the storybooks were counter-balanced to control for order effects.

One parent was asked to participate with the child during each book reading. Siblings or other family members were also permitted, but not required, to participate, as this would be representative of the child's typical home environment (e.g., [33]). Most families read the stories in a family room or living room.

For the computer storybook, the experimenter placed the laptop computer on a table, either a coffee table or dining table, and instructed the parent on how to start the computer storybook. Then the parent was told to read the story to the child as they normally would if reading a computer storybook at home. For the traditional storybook, the experimenter handed the parent the storybook and then told the parent to read the story to the child as they would normally read to their child at home. These procedures allowed us to later assess the kind of parent–child interaction occurring, with a particular focus on scaffolds that could facilitate learning. At the completion of each storybook, a trained experimenter assessed each child's comprehension of the content using the story comprehension test. Parents were given two movie gift certificates as appreciation for their participation.

3.5. Transcribing and coding

Experimenters watched videotapes of the participants and their parents reading each storybook.

Parent–child reading behaviors. Parents and children were instructed to read both books as they normally would in their home. In order to describe parent–child behaviors during the reading of traditional and computer storybooks, we qualitatively examined their interactions from the videotapes for: who was holding the book, how the parent and children were sitting, and where they read the books.

3.6. Parent–child engagement

Based on Vygotskian theory [6] that parent's scaffold children's experiences at developmentally appropriate levels, parent and children's interactions with each other, as well as their interactions related to the storybook or computer content, were analyzed using a coding scheme developed by Laible and Song [14]. Two coders were trained to analyze and code the transcripts based on the developed coding scheme. The coders independently read the transcripts and coded the following categories using a 3-point scale, with 1 being low and 3 being high for each category. To ensure reliability between the two coders, 25% of the transcripts were double-coded; inter-coder reliability was calculated as 79% (Cohen's $K = 0.68$). Disagreements between the two coders were resolved through discussion.

Active parent involvement. Active parent involvement was used to assess parent's level of participation with the child during the media presentation. A parent high in *active involvement* was defined as trying to converse with the child during the story, attempting to elicit interaction from the child throughout the story, and demonstrating a level of interest above and beyond casual acknowledgment of the child's explicit requests—but involvement does not necessarily have to be related to the story. An example of a parent–child interaction that would be scored as high in active involvement is when the mother points to the letter from the cows to the farmer in which the cows are demanding electric blankets. In the letter the cows state that they will refuse to provide milk unless they receive electric blanks. A mother high in active involvement will explain this concept and define this as an ultimatum. By contrast, parents were coded as low in *active involvement* if they were passive, uninterested, interacted very little or only casually responded to the child, or seemed removed from the situation. For example, a mother was coded as low in active involvement if her child repeatedly said things like, "Mom, Mom, Mom!" to get her attention.

Mutuality of communication. Mutuality of communication, adapted from a coding scheme created by Laible and Song [14], coded for the degree to which a parent and child interacted in a smooth, fluent, and emotionally open dialog during the reading experience. Transcripts were coded as high in *mutuality of communication* if the dialog was smooth, fluent, and emotionally open, meaning that the parent and child's verbalizations were appropriate for the age of the child, and the child was able to understand, respond, and continue the conversation with the parent. Transcripts were coded as low in *mutuality of communication* if the dialog was disconnected or overly complicated, meaning that the parent provided random or unrelated information during the story or provided the child with related information that was much more complex than appropriate for the age of the child.

Story engagement. Story engagement coded for the parent's ability to engage the child in the story content. Parents were scored as high in story engagement if the parent actively engaged the child in the story via interaction. For example, parents who consistently brought their child's attention to the story and excited speech while reading the books were scored as high in story engagement. Parents were scored low in story engagement if the parent remained silent, disinterested, or uninvolved in the story being presented.

Turn taking. Turn taking assessed the degree to which the parents' and child's verbalizations went "back and forth" in the conversation. Turn taking was scored as high when a parent appropriately responded to a child's requests, when a parent's request was child-appropriate and elicited a child's response and engagement, or when a parent adjusted their interaction style to meet a child's wants/needs. Turn taking is a key component in active parent interaction and helps to scaffold the learning experience [6]. Turn taking was scored as low when the parent did not ask questions or the parent directed the conversation in their own preferred direction, disregarding the child's interests.

Total parent–child engagement. A factor analysis was conducted with each of the four parent engagement measures (Active Parent Involvement, Mutuality of Communication, Story Engagement,

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and Turn Taking) for the traditional and computer storybooks. For the traditional storybook, all four variables loaded on one factor, eigenvalue = 3.37 and explained 84% of the variance. For the computer storybook, all four variables loaded on one factor, eigenvalue = 2.57 and explained 64% of the variance. Therefore a composite score was calculated called total parent engagement by summing scores on the active parent involvement, mutuality of communication, story engagement, and turn-taking variables and dividing by 4 for each platform.

3.7. Parent–child verbal interactions

Based on Vygotskian theory [6] that parents may provide external verbal descriptions for children as their language develops as a way of scaffolding the experience, all verbal utterances by the parent and the child were transcribed from the start to the finish of the story. Because there was considerable variation in the number of verbalizations across each type of book, the types of verbalizations were calculated based on the proportion of total verbalizations.

Percentage of parent vocabulary. Each time a parent scaffolds the reading experience by providing the definition or synonym for a word or provided a personal example to define a word, the interaction was coded as *vocabulary* development. For example, if a parent said, "Furious is very angry" the utterance would be coded as *vocabulary*. The percent of vocabulary utterances were calculated by dividing the sum of vocabulary utterances by the total number of verbalizations during the storybook to create a proportion score.

Percentage of parent mechanics. Each time a parent made a comment related to the mechanics or use of the storybook, the interaction was coded as a *mechanic*. These mechanic utterances are supportive for the child's learning and understanding of how the book, or tool, works [6]. For example, if the parent told the child to "click here" during the computer storybook or "turn the page" during the traditional storybook, it was coded as a mechanic comment. The percent of parent mechanic comments was calculated by dividing the total mechanics comments by the total number of verbalizations during the storybook.

Percentage of child verbalizations. Each time a child made a comment related to the mechanics or use of the storybook, the interaction was coded as a *child mechanic*. Parent interactions are important ways in which the parent scaffolds the experience, but child verbalizations are crucial for helping the parent understand whether the child is mastering the use of the tool. With an understanding for how the child is using and understanding the tool (books), the parent can adjust their interaction style to ensure that they remain in the ZPD [6]. For example, if the child said, "click here" during the computer storybook or "turn the page" during the traditional storybook, it was coded as a child mechanic comment. Each time a child asked a question related to the storybook, the interaction was coded as a *child question*. For example, if the child asked, "why does Elmo's tummy hurt?" during the computer storybook or "where is the cow?" during the traditional storybook, it was coded as a question. Each time a child labeled or described something related to the storybook, the interaction was coded as a *child label or description*. For example, if the child said, "Elmo's doctor is using a tongue depressor" during the computer storybook or "the cows got blankets" during the traditional storybook, it was coded as a label or description.

3.8. Attention and storybook comprehension

Child visual attention. An experimenter coded visual attention by watching the videotapes. A look began when the child's eyes were directed towards the computer screen or the book and terminated when the child looked away from the screen or book (see e.g. [31,32]). Attention was calculated by dividing the child's total looking time by the total time recorded. Interobserver reliability was measured using intraclass correlations [34]. The intraclass correlation of the proportion of time the child spent looking at the screen for the computer and traditional storybooks was 0.93, based on 17% of the sessions, which was well within the acceptable range of 0.7–1.0.

Child comprehension of content. Each comprehension item was scored as being correct or incorrect. For the computer and the traditional storybook, the number of correct responses to central, plot-relevant content was divided by the total number of questions to yield a percent correct score.

4. Results

4.1. Descriptive statistics

Data from the media diaries examining the child's media use indicated, that on average, children spent 5 min (SD = 16 min) using a computer and 12 min (SD = 23 min) reading books on average per day. According to the parent questionnaire, 54% of the children used a computer and the average age of first computer use was 30 months (SD = 9.05), a finding consistent with nationally representative data for this age group [21,35,7].

Child participants scored 1SD above average on the PPVT measure of vocabulary (M = 81st percentile, SD = 21.5). This finding is not surprising given the family demographics of the participants in this study. Chi-square analysis indicated that were no significant differences in reported familiarity with the computer storybook, *Elmo Goes to the Doctor* or the traditional storybook, *Click Clack Moo*, $\square^2(6,\ N = 47) = 10.92,\ p = \text{n.s.}$ Q10

Parent–child reading behaviors. To answer RQ1, we report results on parent–child reading behaviors and the way in which parents and children engaged with one another in relation to each platform. Parent–child behavior was very similar across both book-reading experiences. During the computer book, parents almost always placed the laptop on a table and sat either on the floor, couch, or in chairs next to their child. Only four of the parent–child pairs read the computer storybook with the child sitting on the parent's lap. For the traditional book, children often sat on the couch or on the floor with their parent as their parent read them the story. Only 5 of the parent–child pairs read the traditional book with the child sitting on the parent's lap. Only 1 parent–child pair had the child sitting on the parent's lap for both the traditional and computer storybook. The primary difference in parenting behaviors involved control of the reading device (either the book or computer mouse). Approximately half of the children controlled the mouse during the computer storybook, which increases children's engagement [35], but the vast majority of parents held the book during the book reading experience. Only 1 child held the traditional book and that child only held it for part of the story.

Total parent–child engagement. Parent–child engagement across both book types was correlated, $r = 0.329,\ p = 0.05$. However, there was a significant difference in the total parent–child engagement between traditional ($M = 2.08,\ \text{SD} = 0.78$) and computer ($M = 2.42,\ \text{SD} = 0.57$) storybook reading, $F(1, 35) = 6.43,\ p = 0.02$. Parents were more engaged with their children during the computer storybook than the traditional storybook. This finding supports Hypothesis 1: that parents will be more engaged with their children during computer storybook reading than traditional storybook reading.

Percentage of parent mechanics. A repeated measures ANOVA indicated that there was a significant difference in the percent

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Table 1
Hierarchical regression model for variables predicting story content comprehension.

		Step 1			Step 2		
		B	SE b	β	b	SE b	β
Book	Attention	0.002	0.001	0.137	0.001	0.001	0.11
	PPVT	0.001	0.002	0.362*	0.002	0.001	0.34*
	Parent engagement	–	–	–	0.07	0.029	0.38*
	R^2			$R^2 = 0.14$			$R^2 = 29.0$
Computer	Attention	−0.000	0.006	−0.004	−0.009	0.006	−0.243
	PPVT	0.004	0.002	0.424*	0.004	0.001	0.395*
	Parent engagement	–	–	–	0.169	0.062	0.468**
	R^2			$R^2 = 0.18$			$R^2 = 0.34$

* $p < 0.05$.
** $p < 0.01$.

of verbalizations that were related to book mechanics between the two platforms, $F(1, 32) = 37.14$, $p < 0.01$. Specifically, the percent of mechanic verbalizations during computer storybook reading ($M = 23\%$, SD = 17%) significantly exceeded the percent of mechanic verbalizations during traditional book reading ($M = 4\%$, SD = 4.0). This finding further supports our hypothesis that parents would be more interactive during computer storybooks. Because of the novelty of the platform, parents probably used more verbalizations to direct and aid the child in manipulating and using the platform.

Percentage of vocabulary verbalizations. A repeated measures ANOVA revealed that there was a significant difference in the percent of verbalizations that were related to vocabulary development between the two platforms $F(1, 32) = 8.21$, $p < 0.01$. Specifically, the percentage of vocabulary verbalizations during traditional book reading ($M = 5.4\%$, SD = 10) significantly exceeded the percent of vocabulary verbalizations during computer storybook reading ($M = 0.3\%$, SD = 1.0), $p < 0.01$. This finding supports H2: that parents will vary their interaction styles between the traditional and computer books.

Percent child verbal interactions. Children had significantly more verbalizations during the computer storybook ($M = 37.12$, SD = 22.85) than the traditional storybook ($M = 9.15$, SD = 10.83), $F(1, 32) = 56.93$, $p < 0.01$. A significantly higher percentage of mechanics verbalizations occurred during the computer storybook ($M = 12\%$, SD = 15.79) than the traditional storybook ($M = <1\%$, SD = 1.09). $F(1, 28) = 15.65$, $p < 0.01$. However, there was no difference in the percent of questions and verbalizations made by the child during the computer storybook ($M = 8\%$, SD = 8.77) and the traditional storybook ($M = 13\%$, SD = 23.88). There was no difference in the percent of labels and descriptions made by the child during the computer storybook ($M = 9\%$, SD = 7.89) and the traditional storybook ($M = 14\%$, SD = 22.43). These findings only partially support H3 that children would vary their interactions based on the type of storybook.

4.2. Attention and comprehension to the storybooks

Repeated measures ANOVA's were conducted to examine differences in children's visual attention and comprehension of the storybooks.

Child visual attention. There was a significant difference in attention between the traditional ($M = 86\%$, SD = 16.79) and the computer ($M = 96\%$ SD = 5.68) story. Children attended significantly more to the computer storybook than the traditional storybook. This finding may be a function of increased parental engagement during the computer storybook and their increased use of mechanic utterances to aid the child in using the computer interface. Alternatively, children may have attended more to the computer story simply because of the novelty of the platform or because they were more engaged because they could control the content through the mouse (see [35]).

Children's comprehension of story content. Comprehension of important central story content approached a significant correlation for the book and computer presentations, $r(34) = 0.33$, $p = 0.06$. There were no significant differences in overall comprehension scores for the traditional ($M = 65\%$, SD = 15) and computer ($M = 69\%$, SD = 21) storybooks.

Because attention and language performance (e.g., [30]) and parent–child interaction [15] are often associated with comprehension of content, we used hierarchical regression modeling for each media type to first examine the influence of attention and language scores on story comprehension (Step 1) and then whether additional variance could be accounted for by parent engagement (Step 2). For traditional book reading, the second model was significant $F(1, 28) = 3.71$ $p = 0.03$, $R = 0.56$, $R^2 = 0.31$. The R^2 increased by 0.15 from the first to the second model. In particular, total parent engagement and language scores significantly predicted children's comprehension of content presented in traditional books. See Table 1. For computer use, the second model was also significant, $F(2, 33) = 5.21$, $p < 0.01$, $R = 0.59$, $R^2 = 0.34$. As was true for comprehension of traditional books, language scores and total parent engagement scores were significant positive predictors of story comprehension. The R^2 increased by 0.16 from the first to second model (see Table 1). This finding supports H4: that story comprehension would be influenced by attention to the story and by children's prior verbal comprehension skills, as well as, by their parent's interactions during storybook reading.

5. Discussion

Theoretically, parent interaction during book reading should support children's learning and comprehension, especially if the parent's verbalizations are scaffolding the experience, using the tools available, and keeping the child's learning within his ZPD [6]. Research supports this theory and has demonstrated that the ways in which parents interact with their children during joint book reading can have a positive impact on vocabulary, literacy skills, and social and emotional development [14,13], but all of this research examined parent–child interactions during traditional book reading. Today young children also spend a substantial amount of time using new media devices such as computers and tablets [1,7], which offer online or digital storybooks for young children to read. Given the change in technology and the additional opportunity for young children to read on new digital devices along with the important role that parents play as teachers who structure their children's learning and experiences [6], this study examined how parent and child interactions may be similar and different when reading a traditional and a computer storybook and how parent interaction during both types of storybooks are related to children's comprehension of story content.

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The results of this study suggest that parents and children read the traditional and computer books in similar ways. In particular, parents and children sit together and read the books in comparable ways, regardless of the platform. However, parents and children do adjust their interaction strategies to incorporate new information about the platform. For example, overall parent engagement was higher during the computer storybook compared to the traditional storybook, indicating that parents are more engaged when using computer storybooks than traditional storybooks. Perhaps due to the novelty of online storybooks and the additional opportunity to manipulate and interact with them compared to traditional storybooks, parents and children were both more likely to use mechanic utterances when reading an online storybook than when reading traditional books. This finding supports Vygotskian theory [6] and suggests that parents may provide scaffolds to help their young children understand the content, as well as the platform, when using computers.

Conversely, when reading traditional books, and consistent with prior book reading research, parents were more likely to use verbal definitions as a mediation strategy during traditional book reading, a strategy that is most likely to enhance language development and literacy development skills (see [36]). This outcome is likely because by age 4 most children are already comfortable with the mechanics related to a traditional book and no longer need parental scaffolding to manipulate and understand the mechanics of a traditional book. With less attention dedicated to educating the child about the mechanics of traditional book reading, parents may choose to focus their interactions around vocabulary development.

Despite these differences in specific types of utterances, parents were highly engaged and involved when reading both types of storybooks with their preschool-aged child. Children also were very consistent with their verbal interactions across both storybook types, with the exception of mechanics utterances. The findings from this study provide evidence that parent engagement and child language scores predict comprehension of both traditional and online storybooks.

5.1. Educational opportunities & platform challenges

Traditional book reading is an activity that most (60%) children under age 8 do on a typical day [1]. Conversely, only 14% of children under age 8 use a computer, 17% now uses a mobile device, and just 4% reads a digital book daily [1]. Most parents in our study reported that books (90%) and computers (93%) have educational value. As a result, parents' interactions during media use may vary based on the complexity of the medium or the frequency with which their child has interacted with the specific platform.

Compared to traditional storybooks, the digital and interactive nature of computer storybooks may place different requirements on, and may facilitate different types of, interactions by the parents and children while reading (e.g., [37]). The computer storybook used in this study included additional side activities that the children could do while reading the story. For example, when the children got to the page where Elmo was in the Doctor's office, the computer storybook prompted the children to "look around the office" by clicking on different objects. In this instance, the tool, or the electronic storybook was able to act as the more experienced user and interact with the child in a way that helped scaffold the child's learning [6]. When the child, or parent, clicked on objects in the room, the objects moved or made sounds, thereby directly interacting with the child. For example, if you clicked on the tongue depressors, they bounced around in the jar. Since there were many opportunities for children to get sidetracked by the other activities offered during the computer story (see [35,38]), parents may have altered their interactions to engage their child in the storyline in order to keep the story progressing as these side activities can pull children off task.

In other cases, these activities may have also increased the engagement of both the parent and child in the task, thereby offering opportunities for parents to provide additional scaffolding for the child [6]. For example, in the waiting room at the doctor's office, Elmo sees his friends in the waiting room. The child can click and learn what is ailing each of the friends. If the child clicks on the horse, the horse says, "I'm feeling a little hoarse". These types of computer-driven prompts may spark interaction between the parent and child that may not occur with a traditional storybook. The mother of one child who clicked on the horse defined the word hoarse by saying, "remember when a couple weeks ago mommy's voice was funny—it was kind of hoarse". Because the online book provides additional prompts and activities, parents may take the interaction a step further and ask the child additional questions or provide additional information during the joint book reading experience, a finding that is consistent with Vygotsky's [6] theory. These findings support related research on distance reading with young children online (e.g., [18]). Alternatively, though, some computer storybooks may provide electronically embedded interaction directly within the book content [39], which may either replace the need of a parent during computer book reading, or may result in enhancing both the child and parents interactions during computer book reading. In this way, computer stories may lead to higher levels of story engagement and active parent involvement when compared to traditional storybooks.

5.2. Comprehension of content

Overall children were equally successful at comprehending the content across both traditional (65%) and computer storybooks (69%). Children's visual attention has often been linked to comprehension for media platforms like television [30]. In this study, by contrast, there was a difference in attention but no difference in comprehension, a finding that was also reported for preschool children's comprehension of content presented in a *Blue's Clues* computer story [35]. Children's visual attention was lower when reading the traditional storybook than the computer storybook. It could be that either children allocated more visual attention to the parent than the book itself during traditional book reading or that children's attention was more highly maintained to the computer storybook due to the dynamic changes occurring on the screen and the control that children had of the story during computer book reading (for a similar argument see, [35]).

Despite looking time differences, for both traditional book reading and computer use, the child's vocabulary level combined with the parents' overall engagement with the child during the story significantly predicted the child's comprehension of the story content. Furthermore, comprehension across the traditional and computer storybooks was moderately correlated. The importance of parent–child engagement during story reading, regardless of the device on which the story is presented or indeed the specific storyline, must be underscored. The quality of parent–child interaction during joint book reading is a key predictor of reading and literacy skills [13] and has been shown to improve oral language complexity and story comprehension [40]. Thus, the building blocks of story comprehension are grounded in preschool parent–child social interactions, a finding that is consistent with Vygotsky's [6] theory. From a practical point of view, the reduced cost associated with downloading digital books might increase access to story content on computers, tablets, and other mobile devices that could actually increase the amount of time that parents and their children spend together reading books. If this is the case, it is particularly important that parents realize that parental engagement is associated with enhanced story comprehension, regardless of the device on which the story is presented.

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5.3. Implications for electronic book design

Our findings have three important implications for the design of ebook experiences for young children. Design of future devices and content must continue to consider the basic abilities of children (e.g., [5,41]), the fundamental principles of parent–child interaction [6], and the context in which use is occurring [42]. The cognitive abilities and capacities of young children are developing rapidly during the early childhood years. As a result learning from books and computers (e.g. [25,24,43,44]), and even television can be challenging [5]. Future research and application design should consider the factors that either facilitate or interfere with young children's learning from computers. Specifically, it is important to examine additional design features in the traditional and computer ebooks to determine if they interfere with comprehension of the narrative as has been found in some research (e.g., [24,45]). More specifically, design features may be incorporated at different times or in alternate settings in ebooks depending on the goals of the experience. For example, ebooks could offer versions with and without extra features to be utilized for different learning goals. The extra features version may be useful for children to learn mechanics of new devices whereas the no extra features version would be useful for times when comprehension of the narrative is the focus of the book reading interaction. This research strategy might be particularly important in order to disentangle whether increased interactivity with touchscreen devices facilitates learning over and above more cognitively challenging devices like the mouse (e.g. [4]).

The scaffolding and bidirectional nature of interactions during traditional and computer book reading supports Vygotskian theory [6] in that the process of learning about all cultural tools is a bidirectional process with scaffolding provided by parents and other experts with children ([43] for review). As demonstrated by the present findings, parents can be valuable collaborators to facilitate navigation with new cultural tools such as computers and ebooks [43] and future design should consider the important role that parents play in the child–computer interaction experience. During preschool development, the parent–child and teacher–child or even peer-to-peer interactions are the most important sources of input in new learning situations. Given that preschoolers cannot read, they will be reliant on parents and caregivers in the navigation of new tools. Even with new technologies and devices, parents are still actively co-using computers and tablets with their young children [22]. Thus, the rapid rate of technology development means that new devices are increasingly available and so consideration of these basic developmental principles and the importance of creating for an adult and child audience remain important for computer-interaction designers.

Third, computer use is occurring in schools and during formal education experiences, but multiple computers and tablets are now also available in children's homes as well [1]. As such, child–computer interactions may be occurring on a range of available computer devices depending on the specifics of the home environment. With computer use occurring so frequently at home for the youngest users, the findings from this study are important for understanding the parent–computer, child–computer, and parent–child interactions that are occurring within the home environment. Put another way, this study provides evidence of the context in which parents and children are using these devices together in their home, which is an important consideration for designers when creating computer content and platforms for family and young child's use. Computer designers may want to consider the environment in which the application is most likely to be used and alter the design to recognize the goals of the experience as well as the other individuals who will likely be partaking in the use of the application with the child. These are important considerations as parent interaction played an important role in the child's comprehension of the content in this study.

5.4. Limitations and future directions

In order to obtain detailed parent–child interaction transcripts, this study was limited in its sample size, the diversity of the families who participated, and to only one child age group. With a relatively homogeneous sample, we were unable to examine the ways in which different types of families differ from one another in how they interact with children during book reading or generalize our findings to other families and their children. Further, this study only examined children's co-reading of a book with a parent in the household with them at the time, not via Skype or another online co-reading platform. These are topics for future research. Currently, we are examining parent–child interactions during book reading and television viewing with low-income minority families. Additional research should expand upon the research by Raffle and colleagues [18] to examine child comprehension of computer storybooks when the adult reading the story is online at a distant place.

Second, as this was part of a larger study, we were unable to get as many measures about the parent as we would have liked. In particular, we did not obtain a measure of parents' technology experience or comfort, which may have played a role in the ways in which they interacted with the computer storybook as well as with their child during the experience. Since, all parents owned a computer, we can assume that a base level of technology comfort existed for these families but future research should control for parents' technology comfort and experience.

Third, there are limitations due to the content that we selected to test for each media type. For this study we were most interested in comparing how the same set of parents altered their interaction styles across the traditional and computer storybooks when reading within the home. Therefore we relied on a within-subjects design. To maintain parent and child interest, we selected content that varied across platform, rather than selecting one storyline that could be used as a traditional and computer storybook. As a result the content was not identical for both readings, which may have influenced how parents interacted with the media, as well as how the child performed on the story comprehension measure. Despite these differences in content and device, parent engagement and child vocabulary predicted comprehension of the content. These findings suggest that child language skills coupled with engaged parents are a key to learning regardless of the content or device. Future research should compare parent–child interactions across a range of content including newer emerging technologies, such as touchscreen computers and apps that are easier for younger children to manipulate.

6. Conclusion

In conclusion, parent–child interactions when reading storybooks were fairly consistent regardless of the platform. Consistent with Vygotskian theoretical predictions, however, parents adjusted their interactions and the strategies that they provided based on the demands of the media platform in relation to their children's skills, which facilitated their children's extraction of content from each medium. Importantly, comprehension of content was predicted by similar factors across both platforms: the child's attention and vocabulary were predictive of story comprehension as was parents overall engagement with the content. The present findings suggest that the benefits of book reading could be introduced to almost every family via computers and have similar benefits of engagement and comprehension as traditional books (e.g., closeness of parent–child interactions is similar, comprehension level is similar, learning mechanism via parent child interaction is similar). Thus, our results suggest that a storybook is a storybook, be the story presented in paper or electronically.

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