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2020

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Recommended Citation

Troseth, G. L., Strouse, G. A., Flores, I., Stuckelman, Z. D., Russo Johnson, C. (2020). An enhanced eBook facilitates parent-child talk during shared reading by families of low socioeconomic status. Early Childhood Research Quarterly, 50(1), 45-58. Special Issue: Intervention Research Addressing the Word Gap: Improving the Language-Learning Opportunities for Infants and Young Children. https://doi.org/10.1016/j.ecresq.2019.02.009

An Enhanced eBook Facilitates Parent-Child Talk During Shared Reading

by Families of Low Socioeconomic Status

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Abstract

Language input plays a key role in children's language development, but children from families of low socioeconomic status often get much less input compared to more advantaged peers. In "dialogic reading" (Whitehurst et al., 1988), parents are trained to ask children open-ended questions while reading, which effectively builds expressive vocabulary in at-risk children. In the research reported here, a dialogic questioning character in a narrated eBook provided effortless support for parents to ask questions while reading. Parents of lower socioeconomic status talked more than three times as much with their children using significantly more utterances and unique words when using the eBook with questioner, compared to parents using the unmodified eBook. Children also talked much more, with more varied language, in this condition. By the end of the session, parents took over asking their own unprompted questions and engaged in more conversational turns with their children. This intervention has promise to increase parent-child conversation to help bridge the word gap.

Keywords: dialogic reading, word gap, eBook, co-reading, vocabulary development

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Differences in children's vocabulary development associated with family socioeconomic status begin to appear during the second year of life, and contribute to an overall achievement gap once children enter school (Farkas & Beron, 2004; Hoff, 2013; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Mancilla-Martinez & Lesaux, 2011; Rowe, 2008). Toddlers of different socioeconomic backgrounds exhibit very early differences in the efficiency of their language learning. In a study that followed children over time, SES-related disparities in real-time language-processing efficiency and vocabulary development were present at 18 months (Fernald, Marchman, & Weisleder, 2013; Hurtado, Marchman, & Fernald, 2008). By 24 months, toddlers from families with fewer resources were already six months behind their more advantaged peers in the processing skills needed for language development. Research shows that the vocabulary gap widens during the school years, with vocabulary knowledge mediating the relation between children's socioeconomic background and their processing efficiency for word learning (Maguire et al., 2018).

The Input Problem

Differential language input, or a disparity in opportunities to learn language (Carter & Welner, 2013), is central to these processing differences. Compared to mothers of higher-SES backgrounds, those with limited education and resources talk less to their children using less varied vocabulary (Hart & Risley, 1995; Hoff, 2003b; Rowe, 2012). In their seminal study, Hart and Risley reported a "30 million word gap" in cumulative exposure by age 3 between the children of welfare recipient families and professional families. Critics of this work identify certain methodological flaws (e.g., socioeconomic status was confounded with race—Dudley-

Marling & Lucas, 2009), but recent research has documented similar language gaps related to family socioeconomic status independent of race (e.g., Fernald et al., 2013; Schady et al., 2015).

Another SES-related input difference involves the variety of words parents use. Parents of higher SES tend to use longer utterances with more diverse words when talking to children, and language quality mediates the relation between family SES and children's language development (Hoff, 2003a). Linguistic diversity may partly reflect different kinds of parent talk: in several studies, parents with more education and resources asked children more questions and used fewer utterances to direct and control children's behavior than parents of lower SES did (Hoff, Laursen, & Tardif, 2002; Hoff-Ginsburg, 1991; Rowe, 2008).

The volume and type of parental language input also can differ widely within socioeconomic group (Weizman & Snow, 2001). During all-day audio recordings, some Spanish speaking parents of low socioeconomic status spoke to their children 18 times as much as other low-SES parents did (Weisleder & Fernald, 2013)—a difference almost as large as that found by Hart and Risley (1995) between the low-SES and professional families in their sample. Importantly, toddlers in these families with socioeconomic challenges who experienced more daily speech were more efficient at processing words in real time and had larger expressive vocabularies at 24 months, compared to their peers receiving less input (also see Hurtado et al., 2008). Toddlers' differential efficiency in language processing mediated the effect of language input volume on vocabulary development. Similarly, in research with young school-aged children, parent-child conversational turn-taking (an aspect of language quality) was related to better language processing (Romeo, Leonard, et al., 2018; also see Zimmerman et al., 2009) and was correlated with stronger connectivity in language areas (Romeo, Segaran, et al., 2018) over and above contributions of SES or the number of words children heard.

In Weisleder and Fernald's (2013) research, individual differences in parent-child talk among the families of low SES were not correlated with parent education, typically the most predictive aspect of SES for child academic outcomes. Rowe (2000) found that the typical relation between parent SES and child language was mediated by parents' beliefs and knowledge about child development; parents more aware of development challenged children with sophisticated language just beyond the child's current developmental level (Rowe, 2008).

Therefore, given the early point at which the long-term trajectory for language development is established, there is a pressing need to find and implement strategies to help families bolster young children's language growth (Hindman et al., 2016). Because vocabulary predicts language comprehension (a core skill for educational and life success), improving preschool children's vocabulary is an important target for intervention (Neuman & Dwyer, 2011). The more words children know when they enter school, the easier it becomes for them to understand new information and to learn new words and concepts (Maguire et al., 2018; Neuman, 2001; 2006).

Shared Reading and Early Vocabulary Development

Book reading is a promising activity in which to promote the rich use of language with children. Parents and children share joint attention toward pictures illustrating the words in the text, setting up an efficient situation for word learning when parents talk about what children are looking at (Akhtar, Dunham & Dunham, 1991; Tomasello & Farrar, 1986). Books introduce children to a range of situations beyond those encountered in daily life (DeTemple & Snow, 2003; Ganea, Pickard, & DeLoache; 2008; Hindman et al., 2016). Children's books contain a wider diversity of words than adult conversation does (Cameron-Faulkner & Noble, 2003; Hayes & Ahrens, 1988; Mesmer, 2016; Montag, Jones, & Smith, 2015), making shared book reading

one of the most effective means of exposing young learners to "lexical reservoirs" (DeTemple &

Snow, 2003) of uncommon words presented in a meaningful context (Bus, van Ijzendoorn, &

Pellegrini, 1995; Dickinson & Smith, 1994; Mesmer, 2016). Perhaps not surprisingly, both

affluent and working-class parents use more words and a broader variety of words while reading

than during other parent-child activities (Crain-Thoreson, Dahlin, & Powell, 2001; Demir-Lira,

Applebaum, Goldin-Meadow, & Levine, 2018; Gilkerson, Richards, & Topping, 2017; Hoff-

Ginsberg, 1991; Payne, Whitehurst, & Angell, 1994; Sénéchal & LeFevre, 2002).

Talking about these unusual words is valuable: parents from low-SES backgrounds who

produced and discussed the meaning of uncommon words had children with more developed

vocabularies (Weizman & Snow, 2001). Rich conversations also offer children conceptual

background knowledge about the words they already know, which prepares them to be efficient

learners in school (Maguire et al., 2018; Neuman, 2001). Therefore, encouraging parents to

converse with their preschool children while reading picture books gives children opportunities

for learning, understanding, and expressing new words.

Interventions for Vocabulary Development

Shared reading experiences strongly contribute to early language growth when parents or

teachers use strategies to engage children in conversation (Coyne, Simmons, Kame'enui, &

Stoolmiller, 2004; Walsh & Blewett, 2006; Wasik, Bond, & Hindman, 2006). In dialogic

reading, adults are trained to use story-related questions that are progressively tailored to

children's growing skill level (Whitehurst et al., 1988). Adults begin with simple questions until

children are familiar with a story. Then they introduce more challenging, open-ended prompts

such as asking children to predict what will happen next, or to connect something in the story

with their own life (Zevenbergen & Whitehurst, 2003). Adults provide feedback to what children

say and model complex responses to questions. The goal is to promote linguistically-rich conversation that encourages children to express themselves.

Parents are taught particular ways to scaffold their children's mastery of complex vocabulary. The dialogic questioning mnemonic C-R-O-W-D reminds them to vary their strategies to elicit children's verbal responses by including *Completion* prompts (complete the sentence), *Recall* prompts ("What happened on that page?"), *Open-ended* prompts (calling for multiple word answers; e.g., "What will happen next?"), *Wh- questions* (Who, what, when, why, where, how), and *Distancing* prompts that relate the story to the child's experiences ("Do you ever do that?") The overall structure of a dialogic reading experience follows a second mnemonic, P-E-E-R: *Prompt* the child to say something about the story (using C-R-O-W-D strategies)*, Evaluate* how correct or complete the response is*, Expand* on the child's response by rephrasing or adding information, and *Repeat* the prompt to encourage the child to recall the information (Whitehurst, Epstein, et al., 1994). Used together, these memory aids help parents adapt to and scaffold their child's developing understanding based on the child's engagement and reading ability.

Dialogic reading improves expressive vocabulary in children age 2 to 5 (Dickinson & Tabors, 2001; Strouse & O'Doherty, & Troseth, 2013; What Works Clearinghouse, 2007; Whitehurst et al., 1988; Zevenbergen, & Whitehurst, 2003) when implemented by parents or preschool teachers (Hargrave & Sénéchal, 2000). Its benefits extend to low income populations (Opel, Ameer, & Aboud, 2009; Vally, Murray, Tomlinson, & Cooper, 2015; Whitehurst, et al., 1999), English language learners (Brannon & Dauksas, 2014; Tsybina & Eriks-Brophy, 2010), and children at risk for reading impairment (Hargrave & Sénéchal, 2000). A key lesson emerging from this research and related approaches (e.g., Coyne et al., 2004; Wasik et al., 2006) is that

vocabulary growth depends both on quantity of reading and quality adult-child talk during reading, which offers additional benefits (Mol, Bus, de Jong, & Smeets, 2008). Parent training in dialogic reading has the potential for long-term impact on early literacy: there is evidence that parents still use the techniques up to two years after training (Huebner & Payne, 2010).

Yet there are limitations in the extent to which these benefits are realized by the children who need them most (Mol et al., 2008). Book reading happens less frequently in the homes of children at risk for later failure (Zill & Resnick, 2006; Zill et al., 2006). A number of studies have reported that parents of children from low-SES backgrounds are less likely to ask questions while reading with their children, sometimes explaining what is happening in the story but "without any attempt to involve the child in thinking about the event" by asking the child questions (Mol et al., 2008, p. 10; also see Bus & van Ijzendoorn, 1995; Huebner & Meltzoff, 2005). Therefore, dialogic reading techniques (which emphasize promoting two-way conversation) may be a relatively novel, complex set of behaviors for parents of low-SES backgrounds to master (Mol et al., 2008). To learn and practice using the complex mnemonic strategies, parents in previous intervention studies typically attended several individual or group training sessions led by highly skilled trainers (Whitehurst et al., 1994; Mol et al., 2008). Accessing this training may be particularly challenging for parents with limited time and resources (Arnold, Lonigan, Whitehurst, & Epstein, 1994; Hindman, Wasik, & Snell, 2016): the need to attend training—expending time and carfare—to learn and practice these effective but unfamiliar strategies could lower the uptake of dialogic reading by families from lower SES backgrounds.

To be effective, interventions to bridge the word gap "need to identify appealing, practical, and feasible strategies to retain families and educators over time" (Hindman, et al.,

2016, p. 3). One promising solution has involved videotaped training: giving parents videos to take home along with written instructions has enabled higher SES parents to adopt dialogic strategies and contributed to increases in children's expressive vocabulary (Arnold et. al, 1994; Strouse et al., 2013) and story comprehension (Strouse et al., 2013) at the end of one month. Arnold et al. reason that being able to watch a videotaped model of other parents using the strategies with their children likely was a big factor in parents' adoption of those skills. In a study that compared training by video alone to training with role-play and discussion (Huebner & Meltzoff, 2005), parents of diverse socioeconomic backgrounds increased their use of simpler dialogic reading skills ("What" questions, labeling, and including the child in conversation) with both methods. However, in-person practice through role-play and discussion was found to be more effective for parents who had less education. In another study, video training only increased the use of some familiar strategies (e.g., Wh- prompts, evaluation prompts), but not less-familiar repetition, recall, or distancing prompts, which (according to the researchers) likely required additional instruction (Blom-Hoffman, O'Neil-Pirozzi, Volpe, Cutting, & Bissinger, 2007). An intervention that gives parents opportunities to practice the strategies while learning them may provide support for learning a broader range of dialogic reading skills.

eBooks as a Promising Solution

Electronic books on interactive touchscreens might be effective tools to promote parent-child engagement (Korat & Or, 2010) and parent training in dialogic reading techniques. Audio narration (a common feature of eBooks) may help parents who are not confident reading aloud. Reminders or examples of dialogic prompts could be triggered by turning the eBook page, so that they are presented to parents at the right moment in the context of the story and its illustrations. Carefully designed eBooks can include audio-visual features shown in research to

help children's language learning, such as animations and sound effects that illustrate difficult vocabulary as the story is read by the narrator (Silverman, 2013; Smeets & Bus, 2014; Takacs, Swart, & Bus, 2015). Avoiding off-topic interactive features (hotspots and games) is equally important, as these are especially detrimental for the language learning of children from families of low SES and children already delayed in language and literacy development (Bus, Takacs, & Kegel, 2015; Kamil, Intrator, & Kim, 2000; Takacs et al., 2015). Interactivity that is entertaining yet distracts children from the story may decrease story comprehension (Bus et al., 2015; Labbo & Kuhn, 2000; Takacs et al., 2015).

Electronic books have been shown to better engage children's interest when compared to paper books (Moody, Justice, & Cabell, 2010; Richter & Courage, 2017; Strouse & Ganea, 2017). Studies with children of various ages comparing the use of eBooks and print books report better phonological awareness (Chera & Wood, 2003; Shamir & Korat, 2007) and emergent literacy gains (Segal-Drori, Korat, & Shamir, 2010), as well as better comprehension and vocabulary outcomes (Bus, Verhallen, & deJong, 2009; Ihmeideh, 2014) with eBooks. In one study, boys with low phonological awareness caught up to and surpassed typically developing children due to their motivation to listen and practice word pronunciations using well-designed interactivity (Littleton, Wood & Chera, 2006).

To help address disparities in opportunities to learn language (Carter & Welner, 2013), however, families across the socioeconomic spectrum would need access to touchscreens. In recent years, digital devices that can display eBooks have been adopted at an increasing rate by families from all socioeconomic groups in the US (Smith, 2013). According to a 2015 study, 90% of toddlers in a low-income, traditionally underrepresented US population had used a touch screen by age 2, and 83% of children under 5 had a tablet computer in their home (Kabali et al.,

2015). The rate of adoption of touchscreens indicates that eBooks designed to promote parent training in dialogic reading techniques could be accessible to socioeconomically diverse families.

Prior research suggests the potential for using an on-screen character to model dialogic questioning. In one condition of an intervention study, a preschool teacher periodically appeared in the corner of lightly-animated video storybooks to ask 3.5-year-old children various open-ended questions related to the story (Strouse et al., 2013). The videos simulated how parents or teachers might responsively increase the challenge level as children became familiar with a story—an aspect of dialogic questioning also supported by other research (Blewitt, Rump, Shealy, & Cook, 2009). For one week, children watched two video storybooks in which the teacher asked simple questions, then for another week watched the same storybooks with the on-screen teacher posing more difficult questions. This process was repeated for two more weeks with new stories. The on-screen questioner offered increasing cognitive challenge but could not tailor her questions to the individual child or give encouragement and feedback—other aspects of responsive scaffolding (and dialogic reading) that are important for learning (Blewitt & Langan, 2016; Strouse et al., 2013).

Supported by varied, dialogic-style questions from the on-screen teacher, the children's word-learning scores were close to those of children whose parents were trained to use dialogic techniques with the storybook videos, and higher than scores of children who watched the videos unaided (although only parent-supported children scored significantly above the control group). The results suggest that an on-screen questioner may provide some support for children's learning, but cannot replace a responsive social partner who can actually converse with children. Therefore, we explored whether the model offered by a character in an electronic storybook would prompt parents to engage in dialogue with their children about the story.

The Current Study

Being exposed to an on-screen model of various kinds of questions in the context of an electronic storybook might help train parents to engage in dialogic questioning and promote more parent-child talk. Rather than having to memorize a complex system of reminders (such as the C-R-O-W-D mnemonic), parents could be offered contextualized, specific examples in the situation of listening to a story with their children. Potentially, this might benefit parents lacking confidence in reading or experience in talking about books with their children (Hindman et al., 2016). In the research reported here, we pursued this intervention method by embedding a character who modeled dialogic questioning techniques for parents into a narrated eBook.

On the title page the questioning character, in a few encouraging sentences, described the importance of parents and children talking together while reading but offered no explicit instructions about different kinds of questions. The goal was to model a variety of question types in context for parents. For each page of the story, we developed questions at two challenge levels, resulting in two versions of the enhanced eBook, similar to the easier and more difficult questions asked by the on-screen teacher in Strouse and colleagues' (2013) video storybooks. On each page, once the story narration finished, the character appeared in the corner of the page to ask a question or suggest a topic for discussion. Near the end of the second version, the character did not automatically ask questions, allowing parents to do so if they chose.

Without the use of Artificial Intelligence, the character could not follow up on what the child said, so he was unable to model the P-E-E-R "evaluating" and "recasting" strategy. Our primary focus was on whether or not parents who were exposed to a brief introduction about the importance of discussion and a character who modeled questioning prompts throughout a short reading session would start to ask questions by the end of the session, and would engage in

conversation with their children while reading. Given the length and complexity of dialogic questioning instruction in previous research, this study should be viewed as a preliminary exploration of the efficacy of this training method.

In the research reported here, we had parents and children listen to our eBook story twice during a single session, either with or without the character's example. Our research questions involved whether there would be condition differences in three main areas: 1) amount and quality of parent-child talk while parents and children listened to the eBook, 2) parent and child engagement with and enjoyment of the eBook, and 3) parent and child learning outcomes, which for the parent included learning to ask questions, and for the child included learning about the story. The participants were families with relatively few socioeconomic advantages, half from an urban area and half from a small-town, rural setting.

We predicted that parents would engage in more reciprocal conversation about the story with their children when given encouragement to talk together and a model of dialogic questioning, and that children would talk more about the story, compared to parent-child pairs who used the eBook that did not contain the questioning character. We also predicted that parents and children in both conditions would find the eBook (with and without the character) to be highly engaging, and that the presence of the character's prompts would not make the story less enjoyable. To assess the potential effectiveness of our eBook as a training tool, we examined whether or not the parents who read the eBook with the questioner would ask their own questions near the end of the session, on pages where the questioner did not automatically model this behavior, potentially demonstrating that they had learned from the modeler. We compared how frequently parents who used the book with and without the character's model asked their children questions on those final pages and the types of dialogic questions parents asked. As a

measure of conversational quality, we looked at the number of conversational turns parents and children engaged in on those pages (e.g., Romeo, Leonard, et al., 2018; Romeo, Segaran, et al., 2018; Zimmerman et al., 2009). Finally, we assessed children's learning of the story content through vocabulary and story comprehension measures, to see if this brief intervention would result in any differential learning by the children in the two groups.

Methods

Participants

Thirty-two children between the ages of 2.97 and 5.11 years old ($M = 4.00$ years, $SD = 0.62$) participated with a caregiver (parent or other guardian). Fourteen of the child-caregiver pairs were recruited from childcare centers in the southern US that serve low income families (eligibility criteria = 185% of federal poverty level) and three from a community center serving a nearby low-income urban area. Fifteen were recruited from Head Start programs in the US Midwest. Parents either returned consent-to-contact forms distributed by the center director, or signed up to be contacted after talking to researchers visiting the center. Children were typically developing and learning English as their primary language. Data from one other family were excluded from analysis due to child uncooperativeness.

Participating children were described on a parent questionnaire as European American (44%), African American (25%), or a member of multiple racial categories (13%); one child was described as Hispanic (3%), one as "another race, ethnicity, or origin" (3%), and 4 parents (12.5%) declined to respond to the child ethnicity question. Twenty-eight (87.5%) of the parents were female. More information regarding the experimental (enhanced) and control groups is shown in Table 1. The research was approved by the IRBs of the two participating universities and carried out with written parental consent.

Materials

Parent-child dyads listened to a narrated English storybook presented on an iPad (*Peg + Cat's The Big Dog Problem*, Oxley & Aaronson, 2016). One of a series of eBooks and print books designed to teach early math concepts, this eBook includes an age-appropriate story with some challenging vocabulary, but does not have distracting embedded games. Parents and children in the control group listened to a version of the eBook that was only slightly modified from the original book produced by the Fred Rogers Company. In light of research indicating that hotspots can distract children from learning (Takacs et al., 2015), a few interactive features (animations and sounds produced by tapping story characters) were removed for this study.

Families in the enhanced condition listened to the same eBook with the addition of our dialogic questioning enhancement. The Fred Rogers Company agreed to modify their existing eBook by adding an interactive character, an African American adolescent named Ramone, whose purpose was to model dialogic questioning for parents and to promote adult-child talk about the story. Ramone is a character in the PBS Kids *Peg + Cat* television program, but he was not previously a character in the eBook.

Two versions of the enhanced eBook were created. Ramone appeared on the title page of both enhanced versions, describing in a few encouraging sentences (lasting 30 seconds in the first version and 24 seconds in the second version) the value of parents talking with their children while reading, but not explicitly teaching dialogic methods. On most pages of the eBook, once the story narration ended, Ramone appeared in the corner of the page to suggest questions parents could use to engage the child in conversation around the story. In enhanced version 1, Ramone appeared automatically on every page, asking a relatively simple question. These include Wh- questions (e.g., "Who is taller, Peg or Cat?", "What do you think is in the special

red letter?") and some Open-ended questions ("Do you think the dog is scary? Why?"). In enhanced version 2, to promote more complex child responses, Ramone suggested challenging questions to parents that called on children to express themselves, including Open-ended questions ("Why do Peg and Cat want to be taller than the dog?") and Recall questions ("What is Peg and Cat's really big problem?") Distancing prompts asked children to make connections between the story and their own life ("Who is the tallest in your family?" "Talk about what you do when you can't reach something.") Challenging Wh- questions required that children draw inferences or reflect on a character's feelings ("Why is Peg excited?")

To encourage parents to take over questioning, on the title page of enhanced version 2, Ramone invited families to read and talk together about the story again. He told them that this time, he would not appear on every page. He encouraged, "It's your turn to do the talking on those pages." Ramone told parents that a coffee cup image in the top corner of the screen would be available on those pages (5 of the 12 pages), and that they could "tap the coffee cup" to get a hint. Parents could then decide when to access Ramone's suggestion.

Study Design

Half of the families listened to the two enhanced versions of the narrated eBook with Ramone in succession. The other half of the families (control group) listened to the narrated eBook without Ramone twice. Parent-child pairs were randomly assigned to one of the two conditions, with the caveat that we attempted to balance children's age, gender, and the site of testing across conditions. The enhanced eBook condition included 9 girls and 7 boys ($M = 3.93$ years, $SD = 0.66$; 9 southern and 7 midwestern children) and the control eBook condition had 8 girls and 8 boys ($M = 4.01$ years, $SD = 0.59$; 8 southern and 8 midwestern children).

Procedures

Sessions lasted approximately 45 minutes and took place in a quiet room at a childcare center (for 23 children), a research lab on campus (5), a community center (3), or the child's home (1). Parents in the enhanced eBook condition read (listened to) the narrated eBook version 1 (enhanced with simpler questions) with their child followed by version 2 (with challenging questions). Parents in the control condition were asked to read (listen to) the narrated eBook (without Ramone) twice. Before each read-through, parents were instructed to read the eBook with their child as they normally would. The researcher accessed the appropriate version of the eBook for the first read-through and handed the tablet to the parent. Parents were asked to let the researcher know when they were done with the first read-through, after which they would be told what to do next. While the parent and child were reading, the researchers left the room or moved to the other side of the room and busied themselves with paperwork to reduce families' feeling of being observed. When the parent indicated that they had finished the first read-through, the researcher showed them how to access the appropriate version for the second read-through, and then left the room. No explicit training in dialogic questioning was provided to the parents at any point during the session. Parents were not given specific instructions on how hold the tablet, so variability occurred across parent-child dyads regarding who held the device and who turned the pages. The reading sessions were video and audio recorded.

Next, parents were given a short, written feedback survey and family demographic survey to complete while their child was asked vocabulary and comprehension questions. Finally, the parent was asked several open-ended questions about the reading experience.

Measures

Amount and quality of parent and child talk. Recorded sessions were transcribed by a trained researcher in the CHAT transcription and coding format developed as part of the Child

Language Data Exchange System (CHILDES) and reformatted/updated for the TalkBank

Infrastructure project (MacWhinney, 2000; 2018a). Each line of the transcript included a three-

character speaker code (PAR or CHI) and the transcription of one utterance. Using Ratner and

Brundage's (2013, p. 12) procedure, a break in utterance was defined when two of the following

three criteria were met: 1) silence or pause of more than 2 seconds, 2) terminal intonation

contour, and 3) syntax completing a sentence or contribution in conversation. To improve

transcription reliability, a second reader reviewed each transcript for accuracy.

The KIDEVAL function in CLAN (a program for transcription, analysis, and annotation

of transcripts in CHAT format, http://alpha.talkbank.org/clan/) was then used to compute

utterance and word counts for parents and children, as well as linguistic diversity. KIDEVAL

automatically computes a variety of language outcomes; those reported here include the *total

number of utterances*, *total number of words*, and *total number of unique words* transcribed for

each speaker. Because our speech samples were not large enough (particularly in the control

group) for the VOCD function to compute *D,* we used unique word counts as our measure of

linguistic diversity. The number of unique words in the language input that children hear is a

common measure of linguistic variation with an established positive relation to children's

vocabulary size (Hoff & Naigles, 2002; Huttenlocher et al., 2010; Pan, Rowe, Singer, & Snow,

2005). KIDEVAL computes the number of unique (different) words used in the sample, with

variations of a word with the same root counted as separate words. More information on the

KIDEVAL program can be found in the CLAN program manual (MacWhinney, 2000; 2018b).

We report the total utterance, total word, and unique word counts for the duration of each

read-through of the book to allow comparison of the overall differences in language exposure

that children received in the reading sessions. Because reading tends to be a context for richer

language use than other daily activities (Hoff-Ginsberg, 1991; Weizman & Snow, 2001), additional time spent reading potentially replaces time spent in less language-rich activities. Thus, the *duration* of reading (and *total exposure* to language while reading) is important. However, because the duration of each read-through differs across participants and conditions, we also provide density measures created by dividing the total utterance, word, and unique word counts by the duration of the read-through. Finally, to ensure that any condition differences in word count were not driven by parents simply repeating Ramone's prompts back to children, we also report total and unique parent word counts after removing all words used by Ramone.

Focus of parent and child language. To examine the extent to which conversation while using the eBook focused on the story, parent utterances were assigned three distinct codes (*content-related* talk, *attention-behavior directing* talk*,* and *off-topic* talk) adapted from coding schemes for parent-child talk used in previous reading studies (Krcmar & Cingel 2014; Parish-Morris, Mahajan, Hirsh-Pasek, Golinkoff, & Collins; Strouse & Ganea, 2017). Content-related talk included questions or comments regarding book content, as well as questions repeated from Ramone. Attention-behavior directing talk included any command, question, or comment that was intended to modify the child's attention or behavior related to the eBook, and resulting feedback to the child. For example, this category included discussion of where to tap on the screen and when to turn pages. Finally, we coded as off-topic any talk that was unrelated to the content of the eBook or behavior of engaging with it. Child utterances were coded into the same categories. When children's responses could not be categorized based on content alone, information from surrounding sentences was used to categorize them. For example, children's direct responses to questions or comments about the story were coded as content-related, even if they were a simple yes/no/don't know response.

Two undergraduate research assistants who were blind to the study hypothesis were trained on the above criteria using practice videos and transcripts of 5 families who participated in a different study using this procedure, but who were not included in this study. The videos from 9 participating parent-child duos (25% of the sample) were double-coded to establish reliability, and the remaining 23 participant videos were coded by one of the coders. The single-measures ICC was computed using a two-way mixed model to examine the consistency of the raters. Intraclass correlations for parent talk were $r = 1.0$ for the number of content-related utterances, $r = .99$ (attention/behavior directing), and $r = .96$ (off-topic). For child talk, intraclass correlations were $r = 1.0$ (content-related), $r = .94$ (attention/behavior-related), and $r = .97$ (off-topic). An utterance could receive more than one code; for instance, one parent utterance was: "And see the little lines on the wall?" [coded as both attention-directing ("see") and content-related]. The next utterance received a single [content related] code: "They're measuring how tall they are."

Parent prompts. For the five pages near the end of the enhanced version 2 book (used for the second read-through) on which Ramone did not automatically appear, trained research assistants counted the number of pages on which individual parents (or their children) accessed Ramone's question by tapping the coffee cup icon and recorded the number of original questions (not including repeats of Ramone's questions) that parents asked on each of those pages.

As a measure of dialogic training outcomes, the first two authors independently categorized parents' independent prompts (those not repeated from Ramone) on these five pages according to the C-R-O-W-D dialogic questioning mnemonic. For our coding purposes, Completion, Recall, Open-ended, and Distancing categories were not treated as mutually exclusive; for example, Distancing prompts may also be Open-ended (e.g., "Why were you

afraid when you saw the big dog at the park?") We reserved the Wh- code for simple closed

prompts that did not fall into any of the other dialogic categories, a useful distinction because

Completion, Recall, Open-ended, and Distancing prompts are considered more challenging than

"What" questions (e.g., What color is it?) that require a one-word or nonverbal answer

(Zevenbergen & Whitehurst, 2003). Non-CROWD prompts (mostly yes/no questions) were also

coded. The two coders categorized all prompts into the six categories and computed totals across

the five pages for each parent in both conditions. Inter-rater reliabilities, as assessed via the

intraclass correlation coefficient, ranged from $r = .87$ to $r = 1.0$.

Parent-child conversation. Research indicates that, beyond numbers and diversity of

words in parent input, the extent of parent-child interactive conversation is also important to

promote children's language learning. As a measure of this kind of conversation in the two

groups of families, one coder counted the number of conversational turns exchanged between

parents and children (defined as discrete pairs of adult utterances followed by child utterances, or

child utterances followed by adult utterances—e.g., Romeo, Leonard, et al., 2018) on the five

pages without Ramone's automatic questions during the second read-through (and the same

pages in the control book). A second coder checked the counts for accuracy.

Reading behaviors. As a measure of *child engagement* through the two read-throughs,

two research assistants blind to our hypothesis coded children's affect and attentiveness from

videotape for each 30-second interval, following methods previously used by Strouse and Ganea

(2017—see for a full description of the coding scheme; adapted from Deckner, Adamson, &

Bakeman, 2006). Read-throughs differed in length between and across parent-child dyads,

resulting in different numbers of 30-second intervals. Coders watched each interval of book

sharing and then assigned it a code for affect and a code for attentiveness. *Affect* was scored from

1 (protesting/crying for 7 or more seconds) to 5 (laughing/smiling for 7 or more seconds), with 3 representing neutral affect (less than 3 seconds [10% of the interval] negative or positive affect) or mixed affect (approximately equal proportions positive and negative). *Attentiveness* (called "availability for reading" by Deckner et al.) was scored from 1 (looking/walking away for 27 or more seconds [90% of the interval]) to 5 (attending for 27 or more seconds). Coders began by individually applying this previously-developed coding scheme to 5 videos of children who participated in a different study, then reviewed the videos/discussed their codes. Then they separately coded videos for 8 participating children (22% of the sample). Inter-rater agreement for ratings of each 30-second interval, measured using a linearly weighted Kappa (e.g., Warrens, 2011), was $\kappa = .94$ for affect and $\kappa = .79$ for attentiveness. The two coders each separately coded half of the remaining videos. Interval ratings were averaged such that each child received a composite score (out of 5) for each read-through for both affect and attentiveness.

Story-specific vocabulary. Six target words from the story were identified as age-appropriate for testing vocabulary that may have been acquired or strengthened through interaction with the story (letter, mailbox, taller, mailing, cuddly, excited). The age of acquisition of these words ranges from 4.75-5.3 years (for letter) to 6.1-6.21 years (for excited); for two words (taller, cuddly), only the root word is listed in the age-of-acquisition word lists we consulted (tall: 4.7-4.95 years; cuddle: 5.3 years—Brysbaert & Biemiller 2017; Kuperman, Stadthagen-Gonzales, & Brysbaert, 2012). To test children's knowledge of each target word, the researcher presented the child with a laminated sheet containing a grid of four images from the eBook. The child was asked to identify the target word by pointing to one of the four images (e.g., "Which picture shows someone who is cuddly?") If a participant failed to point to an image, the researcher prompted, "Can you point to one?" but the target word was never repeated.

The researcher scored children's responses as correct or incorrect, and scores were summed across words for a total score (maximum = 6). A second coder, blind to condition, coded the answers of 22 children (69%) from videotapes with perfect inter-rater agreement.

Story comprehension. After the vocabulary test, children were asked to answer five factual questions about the story (see Appendix A), selected to assess the child's understanding of significant events (e.g., "What did Peg and Cat share?" "Why couldn't Peg and Cat mail the letters?") If children were hesitant to answer, parents were allowed to repeat the question and/or encourage their children to answer. All responses were scored as correct or incorrect by two independent raters who were blind to condition, and correct answers were summed for a total score (maximum = 5). Inter-rater reliability, assessed using the intraclass correlation, was $r = .97$. Discrepancies were resolved by a third coder.

Missing data. Lost video recordings (researcher error) resulted in missing *affect* and *attentiveness* data for 3 participants, whose language and duration data were coded from audio recordings. One of these participants also had a lost audio recording for their first read-through, resulting in incomplete language and duration data for that pair's first read. Two families in the control group did not follow instructions to call the researcher for what to do next after their first read-through; instead, they accessed the enhanced eBook through the book's main navigation menu while the researchers were out of the room. Because these parents heard the introduction explaining the importance of talk during reading, all of the data for their second read-through and their learning outcomes were excluded from analysis. Additionally, one child refused to complete the comprehension questions.

<div align="center">Results</div>

Preliminary analyses indicated that there were no interactions between condition and age, so age is not included in the analyses presented below. For most measures, there were no differences between data from read-throughs 1 and 2, so for simplicity of reporting, scores have been averaged for these variables. *Unique word counts* and *attentiveness* did not follow this pattern; in these cases, scores for the two read-throughs were analyzed separately. When Levene's test indicated that variance was unequal across the two groups, t-tests are reported with a Satterthwaite approximation for the degrees of freedom. Concerns about violations of the normality assumption on several tests were addressed through simple bootstrapping with 10,000 samples. Bootstrapped values are presented with b subscripts.

Reading duration. Adult-child pairs in the enhanced condition spent approximately twice as long with the enhanced eBook ($M = 8.37$ min per read-through, $SD = 2.56$) as families in the control condition did with the control eBook ($M = 4.31$ min per read-through, $SD = 1.55$) , $t(30) = 5.42$, $p < .00$, $p_b = .001$, 95% $CI_b = [2.64, 5.59]$.

Amount of parent and child talk. Parents spoke about three times as many utterances in the enhanced condition ($M = 96.63$) compared to the control condition ($M = 27.28$) and about four times as many words (M's $= 447.81$ vs. 108.50, respectively). Removing all words used by Ramone resulted in original word counts of $M = 284.00$ ($SD = 121.73$) for the enhanced condition compared to $M = 78.66$ ($SD = 83.01$) for the control group, a highly significant difference, $t(26.47) = 5.58$, $p < .001$, $p_b < .001$, *95% $CI_b = [138.75, 268.85]$*.

Because of the differences in session duration, we calculated parents' utterances and words *per minute* (see Table 2). Parents in the enhanced condition spoke significantly more

utterances per minute than those in the control condition did, $t(30) = 4.42$, $p < .001$, $p_b = .002$, 95% CI_b = [3.08,8.26] and significantly more words per minute, $t(30) = 5.14$, $p < .001$, $p_b = .001$, 95% CI_b = [19.41, 42.66].

Children also spoke many more utterances in the enhanced condition ($M = 45.47$) than in the control condition ($M = 11.94$), as well as more words (enhanced $M = 127.34$; control $M = 26.13$). As shown in Table 2, children using the eBook with Ramone did not just listen to the eBook longer, but spoke significantly more *utterances per minute* than those in the control condition did in their shorter reading sessions, $t(24.92) = 3.58$, $p = .001$, $p_b = .006$, 95% CI_b = [1.25, 4.17], and significantly more *words per minute*, $t(30) = 4.57$, $p < .001$, $p_b = .001$, 95% CI_b = [4.98, 12.84].

Quality of parent and child talk (lexical diversity). While using their assigned eBook twice, parents used approximately 3 times as many *unique* (i.e., different) words in the enhanced condition (M's = 120.60 and 130.53 for the two read-throughs) as they did in the control condition (M's = 45.93 and 34.07). Unique words, excluding those used by Ramone, were analyzed using a mixed effects ANOVA with read-through (first, second) as a repeated factor, and condition (enhanced, control) as a between-subjects factor. There was a significant main effect of condition, $F(1,27) = 45.35$, $p < .001$, partial eta squared = .627, reflecting overall higher unique word counts in the enhanced condition ($M = 92.33$, $SE = 6.35$) than in the control condition ($M = 30.82$, $SE = 6.57$), and no significant effect of read-through or interaction.

The number of unique words spoken *per minute* by parents (Table 2) also was higher during the readings of the enhanced compared to the control eBook. There was a significant main effect of condition, $F(1,27) = 9.76$, $p = .004$, partial eta squared = .266 and a significant condition by read-through interaction, $F(1,27) = 7.09$, $p = .013$, partial eta squared = .208, but no main effect of read-through. This pattern reflects the fact that parents in the enhanced condition

not only talked more while using the eBook longer but also *increased* in lexical diversity across the two read-throughs, whereas parents in the control condition *decreased* in lexical diversity.

The number of unique words spoken by children was almost 5 times higher in the enhanced condition (*M*'s = 50.00 and 59.67 for the two read-throughs) than in the control condition (*M*'s = 10.71 and 11.36). For children's unique words *per minute* (Table 1), there was a main effect of condition, $F(1,27) = 17.81$, $p < .001$, partial eta squared = .398, and a significant increase in unique words from read-through 1 to read-through 2, $F(1,27) = 14.26$, $p = .001$, partial eta squared = .346. The read-through by condition interaction was non-significant.

Focus of parent and child language. Language focus is reported as the proportion of the total number of utterances coded as content-related, attention-behavior direction, or off-topic. A single utterance could be coded into more than one category (as when a parent both provided content and a directive in the same utterance) and some unintelligible utterances were not coded, so proportions could sum to slightly more or less than 1 (see Table 3).

Parents in the enhanced condition had a significantly higher proportion of content-related utterances than parents in the control condition did, $t(27) = 2.66$, $p = .013$, $p_b = .022$, *95% CI_b* = [.05, .42] and a lower proportion of attention- and behavior-directing utterances, $t(18.92) = -2.62$, $p = .017$, $p_b = .022$, *95% CI_b* = [-0.39, -0.06]. There was no difference in the proportion of off-topic utterances. Similarly, children in the enhanced condition had a higher proportion of content-related utterances compared to children in the control condition, $t(27) = 2.54$, $p = .017$, $p_b = .031$, *95% CI_b* = [.05,.41]. There were no significant differences in the proportion of attention-behavior-related and off topic utterances.

Parent prompts. For the five later pages on which Ramone did not appear automatically during the second read-through of the enhanced eBook, most parents asked their own questions

rather than accessing Ramone's hint. Two asked original questions on all 5 pages, 7 parents on 4 pages, 3 parents on 3 pages, 1 parent on 2 pages, 1 parent on 1 page, and 2 parents on no pages. Across the five pages, the number of original questions asked by parents who read the enhanced eBook (M = 9.94 questions, SD = 7.09) was significantly higher than the number of original question asked by control group parents on the equivalent pages (M = 0.71 question, SD = .99), $t(15.67)$ = 5.14, $p < .001$, p_b = .001, 95% CI_b [5.87, 12.46]. Ten of the 16 parents in the enhanced group never accessed Ramone's suggested question, and the remaining six parents only did so on a single page; after listening to (and often repeating/rewording) Ramone's question, four of the six went on to ask their own original question(s). To provide a sample of the depth of questions and conversations, transcripts of parent questions and parent-child conversations for two of the pages for both conditions can be found in the Supplementary Materials.

Across the five pages on which Ramone did not appear, the parents in the enhanced group offered significantly more dialogic-style CROWD prompts than the parents in the control group did, $t(15.59)$ = 4.82, $p < .001$, p_b = .001, 95% CI_b = [3.91, 10.10]. The average number of each type of prompt that parents in the two groups offered their children across the 5 pages, along with total dialogic versus non-dialogic questions, are shown in Figure 1. Parents in the enhanced condition asked significantly more Open-ended questions, $t(15.65)$ = 4.29, p = .001, p_b = .002, 95% CI_b = [1.53, 4.27] and provided more Recall prompts, $t(16.03)$ = 3.25, p = .005, p_b = .015, 95% CI_b = [0.80, 2.71]. They also offered more Distancing prompts, although this difference was not significant in the bootstrapped test, $t(15.50)$ = 2.55, p = .022, p_b = .084, 95% CI_b = [0.54, 2.33]. Parents in the enhanced and control groups did not differ in the number of Completion prompts (a strategy not modeled by Ramone) or in the number of simple, closed Wh- questions they asked. Parents in the enhanced group also asked significantly more non-

dialogic (e.g., yes/no) questions compared to the control group, $t(16.48) = 3.84$, $p = .001$, $p_b =$ .008, 95% $CI_b = [1.16, 3.25]$.

Parent-child conversation. On the five pages on which Ramone did not appear automatically, parents and children using the enhanced eBook engaged in an average of 2.31 ($SD = 1.38$) conversational turns (back-and-forth interchanges) per page. In contrast, parent-child dyads in the control group averaged significantly fewer conversational turns per page ($M = .19$, $SD = .29$) on these same pages, $t(16.48) = 6.02$, $p < .001$, $p_b = .002$, 95% $CI_b = [1.46, 2.85]$. The transcripts in the Supplementary Materials illustrate these condition differences.

Reading behaviors. Children displayed mostly neutral *affect*, with occasional smiling and laughing in both conditions (enhanced $M = 3.15$, $SD = .022$; control $M = 3.08$, $SD = .20$) and no significant condition difference, $t(27) = .007$, $p = .373$, $p_b = .383$, 95% $CI_b = [-0.08, 0.21]$.

Children's *attentiveness* scores were heavily skewed; children were highly attentive most of the time during the first read-through (enhanced $M = 4.88$, $SD = 0.16$; control $M = 4.91$, $SD = 0.13$) and the second read-through (enhanced $M = 4.71$, $SD = 0.20$; control $M = 4.71$, $SD = 0.27$). Children in both conditions were slightly (although significantly) more attentive during the first read-through, $t(26) = 4.39$, $p < .001$, $p_b = .002$, 95% $CI_b = [0.10, 0.26]$. There were no condition differences in attentiveness (read-through 1, $t(25) = -0.31$, $p = .758$, $p_b = .743$, 95% $CI_b = [-0.12, 0.08]$; read-through 2, $t(25) = 0.01$, $p = .990$, $p_b = .990$, 95% $CI_b = [-0.18, 0.18]$).

Child learning outcomes. Children's scores on the vocabulary post-test following the two read-throughs of the book did not differ between conditions, $t(28) = -0.24$, $p = .809$, with children generally scoring well (enhanced $M = 4.25$ of 6 words, $SD = 1.29$, control $M = 4.36$ of 6 words, $SD = 1.08$). On the story comprehension post-test, children's scores in the two conditions

were statistically equivalent, $t(27) = 0.09$, $p = .932$. Children correctly answered about half of the comprehension items (enhanced $M = 2.40$ of 5, $SD = 1.24$, control $M = 2.35$ of 5, $SD = 1.45$).

Parent feedback. There was no condition difference in enjoyment of the eBooks, $U = 115$, $p = .544$; all parents rated their enjoyment as a 4 or 5 out of 5 except one parent in the control condition. Parents in the enhanced condition reported that they generally found Ramone helpful, $Med = 5.0$, $IQR = 2$, and not distracting, $Med = 1.0$, $IQR = 2$ (on a scale of 1 to 5). Parents who read the enhanced eBook were close to evenly split on whether they preferred Ramone to pop up automatically ($N = 8$) as he did in the first enhanced version and beginning of the second, or to be triggered when they tapped the coffee cup ($N = 6$), as he did at the end of the second enhanced version.

Discussion

Our eBook-based intervention was designed to offer exposure to a model of dialogic questioning in a transparent, accessible way, with the goal of promoting and training adult-child conversation around stories. This short intervention did encourage more parent-child talk, including the use of a wider range of words by both parents and children, and longer reciprocal conversations. When using the book containing the questioner, significantly more of parents' talk was about the book, and less was aimed at controlling children's behavior.

Parent Questions

On the pages where Ramone did not automatically appear (near the end of the reading session), parents in the enhanced group asked many more questions than the control group parents did while on the same pages. Having observed Ramone's example of a variety of types of questions across the two read-throughs, most of the parents asked at least one original

question per page (averaging just under ten across the five pages) suggesting that they had adopted (at least, in the short run) this strategy for promoting conversation.

The parents used various question types that had been modeled, asking significantly more open-ended and recall questions, and dialogic questions overall, than parents in the control group did spontaneously. Parents did not just ask question of the simple "What's that?" variety as in the case of video training studies—Blom-Hoffman et al., 2007; Huebner & Meltzoff, 2005), but also asked the challenging open-ended types of questions that had been modeled by Ramone, which called on children to give more elaborate answers. It may be that having the chance to repeat (and thereby practice) Ramone's challenging questions on earlier pages helped the parents to benefit from this short training session, since lack of in-person practice limited the effectiveness of video training in earlier studies.

Parents in the experimental/enhanced group also asked significantly more non-dialogic (e.g., yes/no) questions than parents in the control group did: both the dialogic strategies, and the general idea to ask children questions while reading, appeared clear to these parents. Control group parents asked, on average, a single question on one of the five pages. Otherwise, they listened to the narration and turned to the next page. Thus, the parents in our control group acted like untrained parents in other studies—they did not initiate many interactive back-and-forth conversations with their children during the book-reading session (Britto, Brooks-Gunn, & Griffin, 2006; Bus & van Ijzendoorn, 1995; Huebner & Meltzoff, 2005; Mol et al., 2008; Silvén, Ahtola, & Niemi, 2003).

Individual Differences

As is typical in research on parent-child talk (Hurtado et al. 2008; Romeo, Leonard, et al., 2018; van Kleek et al., 1997; Weisleder & Fernald, 2013; Weizman & Snow, 2001; Zimmerman

et al., 2009), there were individual differences in how much parents promoted children's conversation across these pages. Although the majority of the trained parents quickly picked up and began applying the idea of asking their children questions about the story, including the use of specific modeled strategies, two did not engage in independent questioning at all across the five pages, and two others did so only once or twice. Some parents may be more ready than others to adopt the practice of engaging children in reciprocal conversation; as suggested by Rowe (2000; 2008) and by Weisleder and Fernald (2013), those parents may be more attuned to promoting children's cognitive and language development. Another possible reason that some parents did not demonstrate that they had learned to include questions while reading was the limited extent of training. More experience and practice might support other parents' use of dialogic questioning—something easily supplied by an embedded questioner in an eBook, who could be programmed to give additional examples and opportunities for practice in later readings of the eBook, and to explicitly introduce other aspects of dialogic questioning (such as the P-E-E-R dialogic structure) over repeated readings.

The Value of Asking Difficult Questions

Parents who had received the dialogic model asked both simple questions and challenging questions that asked their child to go beyond what was perceptually available on the page, including inference, recall, and distancing prompts that called on children to connect between the story and their own life. One of the principles underlying dialogic questioning (and supported by other research—e.g., Blewitt et al., 2009; Coyne et al., 2004; Wasik et al., 2006) is to increase the challenge of questions over multiple readings of the same book (Arnold et al., 1994; Zevenbergen & Whitehurst, 2003). Lower-challenge questions (closed *Wh-* questions, *yes/no* questions) foster a sense of mastery that encourages children to engage with the story

(Price et al., 2009; van Kleek et al., 1997; Zimmerman et al., 2009). Increasing the cognitive challenge as children get familiar with a story promotes language learning over time (Blewitt et al., 2009; Coyne et al., 2004; Strouse et al., 2013; Wasik et al., 2006) by prompting children to think more deeply, retrieve their language from long term memory, and practice expressing themselves with more words (Strouse et al., 2013).

Parent-child Conversations

In response to parents' increased talk and questions, children reading the enhanced eBook with their parents did express themselves, using more and richer language, including almost five times as many different words as children did who listened to the control eBook. A higher proportion of their talk was about the eBook compared to in the control condition. One parent reflected on her child's answers to questions while using the enhanced eBook, "It really opened my eyes also to my child, that she really captured what was going on in the book."

The parents and children reading the enhanced eBook engaged in 12 times as many back-and-forth conversational turns on the final pages, compared to families who read the control book. Thus, embedding a dialogic questioning model in an eBook appeared to be effective at getting parents and children to talk together more, using more varied language. Frequent adult-child *conversation* (not just exposure to more adult talk) is where children's ability to express themselves with rich vocabulary and grammar develops (Cabell, Justice, McGinty, DeCoster, & Forston, 2015; Dickinson & Tabors, 2001; Maguire et al., 2018; Neuman, 2001; Romeo, Leonard, et al., 2018; Wasik et al., 2006; Weizman & Snow, 2001; Zimmerman et al., 2009). Thus, the proximal effect of exposure to a dialogic questioning model—more parent-child questions and conversation—was fostered with this training method.

Child Learning

The distal effect of parent training in dialogic questioning studies is language learning and story comprehension by children. Because of time constraints in developing the eBook and running the study (described under Limitations), this initial test of the effectiveness of the eBook parent training method included just two book readings in a single session, which made observing differential child learning relatively unlikely. We found no learning differences.

Growth in knowledge of story vocabulary in dialogic reading studies is usually shown after repeated exposure to the same book content over multiple weeks or more of reading and answering adult questions (Aram, 2006; Fleury & Schwartz, 2017; Hargrave & Sénéchal, 2000; Strouse et al., 2013; Wasik & Bond, 2001). Story comprehension has less often been assessed; in one study (Strouse et al., 2013), children whose parents were trained in dialogic techniques outscored a control group on a story comprehension measure after *two weeks* of exposure to that story (6-10 repetitions). As with language learning, children's story comprehension did not differ between the groups after 2 repetitions of the story with or without dialogic reading support.

Limitations and Future Directions

Limited training. In an effort to develop new technology to bridge the "Word Gap", the US Health Resources Services Administration (HRSA) funded first-stage development of 10 projects in 2016, with a very constrained time period between award of the funds and presentation of the technology to a panel of judges. The current project was made possible by the use of an already-developed eBook, but programming the dialogic questioner took most of the allotted time. Therefore, this initial study of the training method's efficacy had several important limitations.

First, relatively small numbers of families participated, and they listened to the eBook just twice in one brief session in a contrived setting (child care center, community center, lab)

while their talk was being recorded. Although using the eBook with the embedded dialogic questioner resulted in dramatic short term differences in parents' use of dialogic questioning and parent-child conversation focused on the story, it will be important to know whether longer use at home over repeated reading would lead to lasting gains in the amount and quality of parent-child conversation, to parents' enduring adoption and generalization of the questioning methods to other books and situations, and to gains in children's vocabulary.

There is reason to think that the appropriate amount of training and exposure would have these effects. Two years after training, parents in one study used 90% more dialogic reading behaviors than untrained peers (Huebner & Payne, 2010). When parents were trained in dialogic questioning with video stories and used the techniques for a month, children had significant pre-test to post-test gains in their standardized expressive vocabulary (Strouse et al., 2013). Child vocabulary gains have been typical in longer studies in which adults were taught to use dialogic reading methods (Hargrave & Sénéchal, 2000; Lonigan & Whitehurst, 1998; Wasik et al., 2006; Whitehurst et al., 1988).

Outcome measures. Another limitation of the current study involved the measure we used to assess child learning. Most children from both groups scored quite high on our brief receptive vocabulary outcome measure using pictures from the story, despite the fact that the words were appropriately challenging in age-of-acquisition tables (Brysbaert & Biemiller 2017; Kuperman et al., 2012). Dialogic reading studies have had a stronger impact for expressive than receptive measures (Mol et al., 2008), possibly because of the method's focus on increasing child talk. Thus, future studies should address children's production of story vocabulary.

Because dialogic reading involves asking children challenging questions over repeated readings of the same book, it is likely to foster depth of word knowledge beyond being able to

associate a label with a picture (Axelsson & Horst, 2013; Bion, Borovsky, & Fernald, 2013; Hadley, Dickinson, Hirsh-Pasek, Golinkoff, & Nesbitt, 2016. Questions about characters' feelings, inference and prediction questions, and distancing prompts that connect between the book and real life may build conceptual networks of related words. A vocabulary test that probes deeper understanding of word meaning may be more appropriate to demonstrate changes in depth of word knowledge resulting from dialogic reading.

Mechanisms. An additional limitation of our study is that we do not know the specific mechanism by which the enhancements added to the eBook promoted changes in parent-child talk around the story. Previous successful dialogic reading interventions included both explicit instruction and modeling of the different kinds of strategies (Blom-Hoffman, O'Neil-Pirozzi, & Cutting, 2006; Blom-Hoffman et al., 2007; Lever, & Sénéchal, 2011). Ramone's 30-seconds-per-read-through encouragement regarding the importance of talking together pales in comparison to the length and detail of explicit teaching in other interventions. Nevertheless, it is likely that both his encouragement and his modeling of specific strategies contributed to parents' adoption of dialogic questioning and their promotion of more lengthy conversations, compared to parents who read the control book with their children. In prior studies that did not structure opportunities to practice taught techniques, parents tended to increase the use of some simple strategies, but not the more complex ones (e.g., Blom-Hoffman et al., 2007; Huebner & Meltzoff, 2005). In the current study, parents made use of challenging questions after training, including open-ended questions and recall prompts, a result that would be difficult to account for based only on Ramone's brief encouragement to converse and ask children questions.

Expanded training. Ramone's modeling did not explicitly teach parents using the C-R-O-W-D mnemonic, but let them discover strategies over time from contextualized examples.

Future research might also include more explicit training from the modeling character, and incorporate other dialogic reading skills such as learning to give feedback by recasting and enlarging on what children say.

      Children reading with Ramone. Additionally, it is an empirical question whether or not preschool children could learn from Ramone's model while reading alone, although it is likely that co-reading the enhanced eBook with the support of an adult will promote more interactive conversation and learning. In a number of studies where children used electronic books on their own versus with an adult co-reader, children showed greater comprehension (Dore et al., 2018) and emergent reading skills (including word reading—Segal-Drori et al., 2010) in conditions with both the adult co-reader and the eBook (even surpassing gains from co-reading a print book—Segal-Drori et al., 2010). In another study, children with low vocabulary were particularly supported in conceptual learning when question prompts were delivered or read aloud by a co-reading adult rather than provided solely by the eBook narration (Strouse & Ganea, 2016).

Parent Feedback about the Dialogic Questioner

      Parents in the current research found value in Ramone's example. Several explained that Ramone encouraged them to ask questions. One mother reported, "I read with her when we're fixing to go to bed and I'm exhausted and tired, and sometimes my mind isn't always sharp, so this like kind of helps with that, by asking questions and encouraging me to do that." Another parent commented, "I never think when I'm reading a book to, you know, ask questions. I think she's getting it because she loves to read. And then she tells me the books. I mean, I never thought to talk about the questions." A father added, "It was good to get in the habit of talking about it because sometimes you just read and you go straight through."

Promoting conversation. In addition to generally promoting talk, parents mentioned that Ramone encouraged them to expand on conversations—even though this strategy was not taught or modeled by Ramone. One parent emphasized the simplicity of Ramone's training: "It's easy to have a pop up because if they ask questions, then I can ask another question." Another parent said, "Who's taller, the height thing, just simple questions like that bring on so many more questions after, you know. Who's taller in the family – or who's shorter, switch it up." Another mother explained, "Sometimes he'd ask a question but then I could ask a different question...and whenever she would answer and then I can ask another question based off that."

New question types. Finally, many parents noted that Ramone asked questions they would not have otherwise thought to ask. A few parents mentioned that the experience of reading with Ramone helped them to better identify age-appropriate questions for the child: "When he popped up the little questions it was like, oh, you know, these are questions she knows. She can answer these. You kind of forget sometimes what they know, because they're working with feelings a lot and I don't think about her working with feelings—she's so tiny! … It's kind of helpful to remind me that she's a smart little child." Some parents mentioned modeled strategies such as: *Recall*: "It made me think more of, 'Wait a minute what kind of questions can I ask?'... I can ask her questions…relative to what was in the book the first time around." *Distancing* prompts: "Some of the questions that he would prompt with were things that I don't typically ask about, like ... relating it back to his real life. Like, oh, "What are some things that you share with your friends?" and *Open-ended* questions: "The second story...I just made up a question, and…she remembered the book, like what was at the beginning of the book. So I mean, it was very interesting to see a child…be able to experience telling the story in how they see it."

Conclusion

Children of families of low socioeconomic status typically are exposed to much less language input and rich, interactive conversation than their more advantaged peers (Fernald et al., 2013; Hart & Risley, 1995; Hoff, 2003b; Rowe, 2012; Schady et al., 2015), which is closely related to less efficient processing of language (Fernald et al., 2013; Romeo, Leonard, et al., 2018) and less development in the brain's language processing areas (Romeo, Segaran, et al., 2018). Differences in early language exposure affect children's ability to learn in school (Maguire et al., 2018) and have profound implications for life outcomes (Heckman, 2006; Shonkoff & Phillips, 2000). As described above, much evidence shows that sufficient exposure to dialogic questioning over time is an effective way for children to learn language. The intervention of using a narrated eBook containing a dialogic questioning character holds promise to help parents with less education (and possibly less reading confidence) gain the skills to promote deep thinking about stories and rich use of language. By building examples and hints into an engaging digital storybook, parent training in these helpful techniques can become self-paced, non-intimidating, and effective.

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PARENT-CHILD TALK WITH AN ENHANCED EBOOK

Table 1
Demographic Details by Group

	Enhanced	Control
	M (SD)	*M (SD)*
Age in years		
Parent	31.15 (8.23)	33.42 (9.98)
Child	3.93 (0.66)	4.07 (0.59)
	N (%)	N (%)
Parent-child dyads	16	16
Gender (Male/Female)		
Parent	8/8	3/13
Child	8/8	8/8
Recruitment location		
Childcare center (Urban South)	9 (56%)	5 (31.3%)
Community center (Urban South)	0 (0.0%)	3 (18.8%)
Head Start program (Midwest)	7 (43.8%)	8 (50.0%)
Parent Education Level		
Some High School	1 (6.3%)	0 (0.0%)
High School/GED	2 (12.5%)	1 (6.3%)
Some College	2 (12.5%)	7 (43.8%)
Technical Degree	4 (25.0%)	3 (18.8%)
4-year College or higher	4 (25.0%)	4 (25.0%)
Did not report	3 (18.8%)	1 (6.3%)
Child Racial/Ethnic Identity		
Caucasian	6 (37.5%)	8 (50.0%)
African American	3 (18.8%)	5 (31.3%)
Hispanic/Latino	1 (6.3%)	0 (0.0%)
Multiple Races	3 (18.8%)	1 (6.3%)
Other Race, Ethnicity, or Origin	0 (0.0%)	1 (6.3%)
Did not report	3 (18.8%)	1 (6.3%)

Table 2
Quantity and Quality of Parent and Child Talk During Reading

| | Count Per Minute | | | |
| | Enhanced | | Control | |
	M	*(SD)*	*M*	*(SD)*
Parent				
Utterances	11.55	3.46	5.83	3.84
Words	53.28	17.20	22.50	16.69
Unique Words				
Read 1	14.37	3.89	10.33	5.85
Read 2	16.58	5.00	9.01	6.19
Child				
Utterances	5.31	1.60	2.58	2.60
Words	14.66	4.78	5.40	6.54
Unique Words				
Read 1	5.78	2.18	2.34	2.84
Read 2	7.27	1.66	2.96	3.38

Table 3

Focus of Parent and Child Talk During Reading

	Enhanced		Control	
	M	*(SD)*	*M*	*(SD)*
Parent				
Content-Related	.75	.16	.52	.29
Attention- or Behavior-Directing	.26	.15	.49	.29
Off Topic	.01	.02	.01	.02
Child				
Content-Related	.79	.20	.56	.29
Attention- or Behavior-Related	.16	.15	.28	.29
Off Topic	.03	.05	.02	.04

Note. Proportion of utterances computed by dividing total number of utterances by the number coded into each category. A single utterance could receive more than one code. Unintelligible utterances were not coded into a category but contributed to the total.

Figure 1. Average number of (a) different types of Dialogic CROWD prompts and (b) Total

Dialogic and Non-dialogic prompts offered by parents across the 5 pages of the enhanced eBook

when Ramone did not automatically appear (enhanced group), and the equivalent pages in the

control eBook (control group).