THE WORDS, THE TEXTS, AND THE INTERACTIONS: OPPORTUNITIES FOR WORD
LEARNING FROM PRESCHOOL STORYBOOK APPS

By

Lori Bruner

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Curriculum, Instruction, and Teacher Education – Doctor of Philosophy

2022

ABSTRACT

THE WORDS, THE TEXTS, AND THE INTERACTIONS: OPPORTUNITIES FOR WORD
LEARNING FROM PRESCHOOL STORYBOOK APPS

By

Lori Bruner

One of the most important benefits of read alouds in the early years is the exposure children
gain to new words. Although many early skills support later reading success, early vocabulary
knowledge improves reading in several ways, including supporting comprehension of words that
children decode; helping children recognize words more quickly; fostering phonological awareness
skills; and increasing children's understanding of content-area instruction. However, the nature of
interactive read alouds in young children's homes is evolving, as families are increasingly turning to
digital texts from a very young age. This phenomenon, coupled with the indisputable benefits of
children reading print books, necessitates a critical need to identify the affordances of digital texts
for young children's vocabulary development. To that end, the purpose of this mixed-methods study
is to examine one type of preschool digital text – interactive storybook apps – for the affordances
they may provide for young children's vocabulary development. Specifically, my study seeks to
understand (a) the degree to which preschool storybook apps introduce new vocabulary words to
young children; (b) the types of words children can learn from these texts; (c) the degree to which
interactive features in storybook apps highlight new words; and (d) to what extent interactive
features closely aligned to the words in the story might promote caregivers' word-related talk while
reading aloud.

To answer these questions, I designed two separate but related studies. In the first study, I
conducted a content analysis of 70 best-selling preschool storybook apps from three popular app
stores: the Apple Store, Google Play, and the Amazon App Store. Using the Words Worth Teaching
List as a guide, I analyzed 26,744 total words from these 70 apps to determine what percentage of

words might be considered new for preschool-aged children. Furthermore, I described the types of words children might learn from these texts using three word-level features: parts of speech, frequency, and word difficulty. Finally, I determined to what extent new words in storybook apps are highlighted by interactive features. In the second study, I conducted an observational study of 37 caregivers of four- and five-year-old children to determine how interactive features closely aligned to new words in storybook apps might promote more word-related talk during read aloud of these texts. During this study, caregivers read four stories each – two print books and two storybook apps in counterbalanced order – for a total of 68,635 words in 148 sessions, totaling over 2,220 minutes of read aloud time.

Findings from this study suggest that preschool storybook apps are ripe with opportunities to learn new words. The sample apps contained a total of 1,376 new words – for an average of nearly 20 words per story. Furthermore, storybook apps highlight approximately 23 percent of new words with interactive features, such as providing examples of a word (18.2 percent); demonstrating the meaning of a word (29.2 percent); or saying the word out loud when a reader taps on a picture of it (35.1 percent). Notably, caregivers talked about significantly more new words with their children when they were highlighted by these interactive features. However, I found that the number of interactive features per word, the types of interactive features in the text, and whether caregivers had engage with the word on the screen (i.e., tap on the screen to activate the interactive features) did not significantly influence whether and how caregivers talked about a new word in the text.

This study contributes to the field's understanding of preschool digital texts and their affordances for young children's vocabulary development, as well as how caregivers use these texts during read alouds in the home environment. The findings from this study have implications for teacher professional development, teacher preparation, community-based outreach programs, and storybook app developers.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1 – INTRODUCTION

Statement of the Issue

Interactive read alouds – a caregiver reading a picture book out loud with their child or a teacher reading a book to a group of preschoolers – provide countless opportunities for children to build language and literacy skills before they can read independently. Among other things, interactive read alouds build children's knowledge of letter names and sounds; help them understand how books "work;" model the structure and grammar of stories; foster vocabulary development; and contribute to reading comprehension later in life by introducing important concepts and themes beyond their everyday environment (Wright, 2019). Children who read with understanding in the early elementary grades gain access to a broader range of texts, background knowledge, and educational opportunities throughout their lifetime (Shanahan et al, 2010), making the opportunity to build early language and literacy skills particularly critical.

Arguably, one of the most important benefits of read alouds in the early years is the exposure children gain to new words. Early vocabulary knowledge has long been established as having a significant impact on literacy learning, as understanding the meaning of words is central to comprehending text (Anderson & Freebody, 1981; Nagy, Anderson, & Herman, 1987; Perfetti & Stafura, 2014; Ouellette & Beers, 2010). Knowing the meaning(s) of many words supports comprehension and as such, the size of children's vocabularies is predictive of both concurrent (Ricketts et al., 2007) and later (Senechal et al., 2006) reading comprehension. In addition, early vocabulary knowledge helps children recognize words more quickly as they read (Amendum, Conradi, & Hiebert, 2017; Hiebert & Fisher, 2007; Compton et al. 2004), fosters phonological awareness skills (Lonigan, 2007; Storch & Whitehurst, 2002; Burgess & Lonigan, 1998), and increases children's understanding of content-area instruction (Wright & Gotwals, 2017; Mercer et

al., 2004; Gonzalez et al., 2010). Longitudinal studies clearly indicate that stronger vocabulary skills in preschool are linked to better reading outcomes over time (e.g., Dickinson & Tabors, 2001).

Yet, the nature of interactive read alouds in young children's homes is evolving, as families are increasingly turning to digital texts from a very young age; nearly 60 percent of families with children ages 0-8 engage in read alouds on a digital device at least once per day (Rideout & Robb, 2020), with 98 percent of families now owning either a smartphone or tablet (Rideout & Robb, 2020). Similarly, the number and availability of electronic storybooks has increased dramatically over the past three decades. The first picture storybook on CD-ROM, *Just Grandma and Me*, appeared in the mid-1990s (Ito, 2009), and since then, have increasingly become a widespread alternative to traditional print books for children. According to the Association of American Publishers (Publishers Weekly, 2021), sales of children's electronic books designed for phones, tablets, and e-readers went from $7 million in March 2011 to $170.5 million in March 2021 – an 11,000 percent increase in just ten years. This transition from traditional print books as the primary source of storybook reading for 3- to 5-year-old children to electronic sources (Burnett, 2010) marks a change in the 'textual landscape' in which young children are growing up.

Preschool digital texts, in particular, provide technological enhancements that make the reading experience qualitatively different from that of traditional print books. Most technology-enhanced stories are loaded with interactive features such as puzzles, memory tasks, visual or sound effects, dictionary functions, or picture labels that appear when a reader activates a hotspot (de Jong & Bus, 2003; Guernsey et al., 2012; Korat & Shamir, 2004). These "hotspots" were originally designed for entertainment purposes, but certain features, such as a dictionary function with word definitions, can also provide useful on-demand support. Like print books, most electronic books designed for preschool-aged children present text and illustrations on a screen (although a few exchange the text for a narrator), but the amount and types of interactive features often vary widely

between different texts (Zipke, 2013; de Jong & Bus, 2003; Guernsey et al., 2012; Zucker, Moody, & McKenna, 2009). The most basic digital texts are simply words and illustrations from a book inserted into an app, with the added option to listen to an oral reading of the story. At the other end of the spectrum, digital texts with the most enhancements have characters that move and talk, objects that transform when tapped, or extended graphics that are revealed when the reader moves the screen from side-to-side.

As digital stories have exploded in popularity over the past decade, researchers have begun examining the affordances of these texts for young children's learning environment. One area that has been explored broadly is the impact these interactive features might have on the reading experience. For instance, research has established that digital texts with certain features can be more beneficial during interactive read alouds than others. In one such study, Parrish-Morris and colleagues (2013) found that digital texts enhanced with games and other potentially distracting elements offer observably different co-reading experiences than print books and basic electronic texts. Comments on how to hold the device or how the electronic pages are turned dominated caregivers' talk during interactive read alouds of these texts, with fewer instances of meaning-focused talk than when they shared print books. Conversely, several other studies have found that digital texts with features carefully aligned to the story content promote greater amounts and higher-quality adult-child interactions. For example, Troseth and colleagues (2020) found that an enhanced digital text with embedded comprehension questions encouraged significantly more adult-child talk during read alouds, including the use of a wider range of words by both caregivers and children, as compared to a digital text without interactive enhancements.

Despite the widespread availability of smartphones and tablets, and the number of caregivers who are now turning to these devices to read with their children, no known studies have looked closely at the specific features in digital texts that might draw attention to word learning experiences

on the screen or the opportunities children might have to learn new words from these stories. To that end, the purpose of this mixed-methods study is to examine one type of preschool digital text – interactive storybook apps – for the affordances they may provide for young children's vocabulary development. To do so, I position the words in the stories, the features of the text, and the interactions between children and caregivers alongside one another to describe how these elements work together during interactive read alouds. I also explore the affordances of storybook apps for increasing access to texts in communities that have been historically under-resourced. Studies have shown that access to print resources—board books, stories, and informational books—early on in a child's development has both an immediate and long-term effect on their vocabulary development (Allington et al., 2010). Yet, many families lack access to children's texts in their communities (Neuman & Celano, 2001; Neuman & Moland, 2016). With most families now owning either a smartphone or a tablet (Rideout & Robb, 2020), these devices have the potential to serve as a resource in which to provide access to children's texts.

Finally, while many digital texts include the option to use a narrator to simulate the experience of reading or listening to a story, I focus on the interactive read aloud experience between caregivers and children (i.e., the caregiver reading the text, not the app). This is a crucial distinction given that interactive read alouds can help foster children's vocabulary skills, particularly when caregivers use texts as an opportunity to talk with their children about words (Arnold & Whitehurst, 1994; Whitehurst et al., 1988; Lonigan & Whitehurst, 1998; Zevenbergen & Whitehurst, 2003; Senechal, 2006; Mol et al., 2008; Hindman, Skibbe, & Foster, 2014). As such, it is my perspective that we should not try to replace caregivers with the narration in digital texts, but instead, explore whether and how interactive features might support caregivers to talk about words with their children.

Overview of the Present Study

While research indicates that educational media may provide a beneficial context for vocabulary gains in the preschool years (Marulis & Neuman, 2013; Segers et al., 2006; Korat and Shamir, 2008; Smeets and Bus, 2014), little is known about the words children might encounter in preschool digital texts or the specific mechanisms unique to this context that draw attention to word learning experiences on screen. Therefore, my study seeks to understand (a) the degree to which preschool storybook apps introduce new vocabulary words to young children; (b) the types of words children can learn from these texts; (c) the degree to which interactive features in storybook apps highlight new words; and (d) to what extent interactive features closely aligned to the words in the story might promote caregivers' word-related talk while reading aloud.

To do so, I designed two separate but related studies. In the first study, I conducted a content analysis (Hoffman et al., 2011; Krippendorff, 2013) of 70 best-selling preschool storybook apps from three popular app stores: the Apple Store, Google Play, and the Amazon App Store. To develop a representative understanding of new words in preschool storybook apps, I collected the Top 50 paid and Top 50 free apps listed in the "books" or "education" sections from all three stores over a six-week period in November and December 2020. Additionally, I obtained lists of highly rated or awarded apps from Common Sense Media, Parents' Choice Awards, and Children's Technology Review. Using the Words Worth Teaching List (Biemiller, 2009) as a guide, I analyzed 26,744 total words from these 70 apps to determine what percentage of words might be considered new for preschool-aged children. Furthermore, I described the types of words children might learn from these texts using three word-level features: parts of speech, frequency, and word difficulty. Finally, I adapted a coding scheme developed by Danielson, Wong, and Neuman (2019) to determine to what extent new words in storybook apps are highlighted by interactive features and to

describe the different ways these features might support children's word learning. The following research questions guided this study:

1. What percentage of words in preschool storybook apps might be considered new words for children of this age?

2. Of these new words, what are their features in terms of these three variables: parts of speech, frequency, and word difficulty?

3. To what degree do interactive features highlight new words in preschool storybook apps?

In the second study, I observed 37 caregivers of four- and five-year-old children to determine how interactive features closely aligned to new words in storybook apps might promote more word-related talk during read aloud of these texts. During this study, caregivers read four stories each – two print books and two storybook apps in counterbalanced order – for a total of 68,635 words in 148 sessions, totaling over 2,220 minutes of read aloud time. Participants for this study were recruited through three avenues: free and low-cost preschool programs (e.g., Head Start), tuition-based preschool programs, and – to reach families not currently enrolled in a preschool program – online parent listservs (e.g., the Michigan State University Parent Listserv). To determine whether interactive features impacted the amount of word-related talk caregivers engaged in with their children, I used findings from the first study to identify all the places where new words occurred in the four preschool storybook apps. Then, using this data as a guide, I viewed the 148 videos of the read aloud sessions and identified all the places in the videos where caregivers talked about new words with their children. Moreover, I identified any additional words that caregivers talked about, even if these words were not coded as "new" in the first part of the study. This analysis allowed me to describe the amount and types of words caregivers talked about with their children as well as determine whether there was a significant difference between words that were highlighted by

6

interactive features and words that were not. Additionally, I explored whether and how different types of interactive features influenced the words caregivers talked about in the text and the various strategies they used to do so. The following research question guided this study: How might interactive features closely aligned to the words in storybook apps influence caregivers' word-related talk?

Contribution of the Study

Given that caregivers are increasingly turning to digital texts to read aloud, there is a critical need for research that examines the affordances of these texts for preschool children's vocabulary development. As such, I examine 70 top-selling storybook apps to determine the extent to which preschool storybook apps introduce new vocabulary words, the types of words children can learn from these texts, and the degree to which interactive features in storybook apps highlight new words. Furthermore, research clearly indicates that children need interactive and social experiences to benefit optimally from both print books and digital media (Lauricella et al., 2016; Strouse & Troseth, 2014; Dore et al., 2018; Senechal, 2006; Mol et al., 2008; Hindman, Skibbe, & Foster, 2014). Therefore, I also analyze nearly 150 videos of read alouds in both mediums to determine the extent to which interactive features in storybook apps might promote caregivers' word-related talk. Through these objectives, my study contributes to the research base in three notable ways: (1) it is the first study to closely analyze the words children might encounter in preschool digital texts; (2) it is the first study to examine the specific mechanisms unique to this context that draw attention to word learning experiences on screen; and (3) it explores to what extent the alignment of interactive features to words in the text impacts adult-child interactions; in this regard, this study is one of the first to attempt to disentangle the effects of specific kinds of interactivity built into digital texts.

The results of this study will benefit caregivers, educators, and community-based outreach programs by identifying and providing recommendations for which storybook apps might be most

beneficial for preschool children's vocabulary development. To date, little research has examined which books introduce certain types of words or how caregivers and/or early childhood educators can make informed decisions about which texts provide optimal vocabulary exposure. As such, one of the goals of my study is to identify preschool storybook apps that are particularly rich in word learning opportunities. In this regard, I identify which apps contain a significant percentage of new words in the text as well as apps that contain the different types of words that children will need to be successful readers later in elementary school (i.e., different parts of speech; words at varying levels of difficulty). Furthermore, I identify storybook apps that highlight a significant portion of these new words with interactive features – an element unique to digital texts that might support caregivers to talk about words with their children while reading aloud.

In addition, the findings from this study have practical significance for app developers, who can use this information to design apps that promote and scaffold children's word learning. Collaboration between app developers and early childhood researchers is currently lacking, yet it is indispensable if we are to integrate word learning experiences into digital texts. In this type of partnership, early childhood researchers can use their expertise to recommend new words to highlight in the texts while app developers can use their digital design skills to create interactive features around these words. This type of collaboration would ensure storybook apps provide an optimal learning experience for children, while not detracting from the story content or the enjoyment of reading together with a caregiver. Taken together, this study addresses a timely and critical need to explore the hidden potentials of preschool storybook apps for young children's learning environments.

CHAPTER 2 – CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

This chapter focuses on the conceptual framing of this study and the research relative to children's word learning during interactive read alouds of both print books and digital media. First, I present the theoretical and empirical work that frames this study. Then, I discuss research focused on the nature of new words in texts, factors that impact children's word learning, and the role of caregivers in promoting word learning while reading aloud. Finally, I present research on digital texts and educational screen media that highlights the potentials that preschool interactive storybook apps might hold for young children's vocabulary development.

Conceptual Framework

This study is framed by theoretical and empirical work centered around language learning from texts, particularly as it pertains to how children develop vocabulary knowledge through interactive read alouds with caregivers in their home environment. In this section, I discuss theories and research relevant to the role of texts in interactive read alouds (RAND, 2002); how screen-based content might support young children's language development (Paivio, 1986; Neuman 1997, 2009); and how language development occurs through interpersonal interactions (Vygotsky, 1978; 1986).

The Role of Texts in Interactive Read Alouds

This study draws on the RAND Model of reading, which suggests that the act of reading is an interaction between the text, the activity, the reader, and the broader sociocultural context in which they are situated (RAND, 2002). During interactive read alouds with young children, both adults and children bring to the act of reading their cognitive capabilities (attention, memory, inferencing, visualization); motivation (a purpose for reading, interest in the content, self-efficacy as a reader); knowledge (vocabulary and topic knowledge); and experiences (RAND, 2002). In addition, the reading activity involves one or more purposes or tasks, some operations to process the text, and the outcomes of performing the activity – all of which occur within a specific context (RAND,

9

2002). Furthermore, the context extends far beyond the immediate interaction to include the sociocultural environments in which children live and learn to read.

The features of any given text have a large impact on comprehension (RAND, 2002). Digital texts present particular challenges with their many interactive features that may delineate from (e.g., embedded games) or loosely align to the story content. However, digital texts also have the potential to support comprehension by providing additional content or other supplementary material that help explain the meaning of difficult words. While the text is just one element of interactive read alouds, analyzing the texts themselves is important because they serve as the basis for the language interactions around the story. As such, the actions of adults may be limited or enhanced by the nature of the words in books. Furthermore, some texts may be better suited than others when building vocabulary is the main purpose for reading (Mesmer, 2016). Therefore, the primary goal of this study is to examine one type of digital text – preschool storybook apps – to understand (a) the degree to which they introduce new vocabulary words to young children; (b) the types of words children can learn from these texts; and (c) the degree to which interactive features in storybook apps highlight new words.

Learning from Screen-Based Content

Like other studies of preschool digital media (Bus, Takacs, & Kegal, 2015; Neuman, Wong, Flynn, & Kaefer, 2019; Danielson, Wong, & Neuman, 2019) this study draws from two complementary theories to understand how screen-based content might support children's word learning from digital texts. These two theories are dual-coding theory (Paivio, 1986) and a theory of synergy (Neuman, 1997, 2009), which collectively assert that multimedia – such as interactive storybook apps – provide multiple sources of information to support learning. Dual-coding theory assumes that there are two cognitive subsystems: one specialized for the representation and processing of nonverbal objects/events (i.e., imagery), and another specialized for processing

10

language. The theory proposes that when verbal and nonverbal information is simultaneously processed in the brain, children form interconnections between these pathways that create rich representations of words that can facilitate learning. Thus, processing the two kinds of stimuli simultaneously does not result in cognitive overload but, on the contrary, supports children's learning. For instance, when children are introduced to the meaning of the word *glisten* alongside an image of sunshine sparkling off fresh snow, their opportunity for word learning is enhanced through both the verbal explanation of the word and an image that illustrates its meaning.

Likewise, the theory of synergy (Neuman, 1997, 2009) suggests that when children are exposed to multiple media presentations over time, there is a critical synergy among them that provides children with robust representations of content and deepens their understanding. In contrast to one medium (like television) displacing another (like reading), children often engage in a spirited interplay between different types of media (Neuman, 1995). As interests are established, children are likely to alternate between digital and print mediums based on their accessibility and their capacity to make optimal use of a particular medium. The theory of synergy is based on two ideas: (1) that there are qualitative differences in the content of print and digital mediums; and (2) that the skills acquired from media act conjointly in helping children construct meaning and generate inferences in new contexts (Neuman, 1997). In this study, I draw from both theories to explore the amount and types of interactive features in preschool storybook apps that might support children's word learning from these texts.

Social Nature of Language Learning

Finally, preschool aged children, who are typically not yet reading independently, heavily rely upon the adults in their lives to access texts. As such, this study draws on the social interaction theory of language acquisition (Bohannon & Bonvillian, 2001), which theorizes that language develops through interpersonal interactions. Vygotsky (1978, 1986) particularly emphasized the role

11

the adults in a child's life play in supporting language acquisition. Likewise, Bruner (1978) suggested that caregivers provide a supportive communicative structure (i.e., scaffold) that facilitates language development. From the social interactive perspective, caregivers play a significant role in the language development of their children, as they expose them to language through both talk and texts.

Empirically, many studies with young children have found a relationship between the language used in the home environment and young children's oral language and vocabulary development (e.g., Dickinson & Tabors, 1991; Beals, 1997; Weizman & Snow, 2001; Snow & Beals, 2006; Rowe, 2012; Rowe & Snow, 2020; Anderson et al., 2021). For example, Dickinson and Tabors (1991) found that engaging young children in certain kinds of conversational language experiences, such as explanatory and narrative talk at mealtimes at home and interactive read alouds at school, supported the development of their vocabulary and other literacy-related language skills. Relatedly, Beals (1997) found that the more often caregivers used rare words in informative ways during a child's preschool years, the greater their vocabulary at age five and age seven. Likewise, Weizman and Snow (2001) found that the degree in which caregivers used sophisticated words with their five-year-old children and the density with which such words were embedded in helpful or instructive interactions independently predicted over a third of the variance in children's vocabulary performance in both kindergarten and 2nd grade. Similarly, Rowe (2012) found that caregivers can scaffold their children's vocabulary acquisition at different points in their development by providing them with exposure to different types of talk: the quantity of caregivers' input was most related to subsequent vocabulary skill at 30 months, while vocabulary diversity and sophistication was most related to vocabulary skill at 42 months, and the use of decontextualized language was most related to vocabulary skill at 54 months. Anderson and colleagues (2021) reached similar conclusions: they found that the quality of caregivers' interactions may be relatively more important for children's

language development beginning in toddlerhood than the sheer amount of speech to which they are exposed. That is, using sophisticated words and more complex phrases may not be beneficial to very young children, but instead may be more relevant during the toddler and preschool years.

Together, these studies demonstrate the significant impact of caregivers' interactions on children's language development – particularly the use of rare or sophisticated words during the preschool years. As such, in this study, I examine how caregivers talk about new words while reading aloud, and importantly, how the interactive features in storybook apps might influence the amount and type of word-related interactions caregivers engage in with their children. This is important because little is known about how the mechanisms unique to digital texts might promote word-related talk between caregivers and children.

In summary, my goal for this study is to examine the affordances of preschool storybook apps for young children's vocabulary development. In doing so, I position the texts and the words within them as an important component of the adult-child-text triad. Given that this is primarily a study of digital texts, I also draw from the theory of synergy (Neuman 1997, 2009) and dual-coding theory (Paivio, 1986) to understand how screen-based content might support children's word learning. Additionally, I consider the important role that caregivers play during read alouds by examining the ways in which storybook apps might promote word-related talk through the interactive features aligned to new words in the story.

In the following sections, I present an overview of the literature related to the questions explored in this study. Specifically, I discuss research related to the nature of new words in texts; factors that impact children's word learning; and the role of caregivers in promoting word learning during interactive read alouds. Finally, I present research on digital texts that highlights the potentials that preschool interactive storybook apps might hold for young children's vocabulary development.

Literature Review

When young children participate in interactive read-aloud experiences, both their expressive and receptive vocabulary learning may be impacted (Bus et al., 1995; van Kleeck et al., 2006; Lonigan & Shanahan, 2009; Mol et al., 2009). However, effect sizes range considerably between studies – a disparity that might be attributable to the texts read and the words within them (Mesmer, 2016). Although few studies have examined the relationship between the words in texts, children's acquisition of them, and how words might influence caregivers' talk, research in the following areas can support elements of this study: (a) the nature of new vocabulary words in picture books; (b) word-level factors that impact children's word learning from texts; (c) caregivers' interactions during read alouds; and (d) how digital texts might influence these interactions. In the following sections, I describe the research base for each component. Throughout this discussion, I will also weave findings from my own study of words in preschool texts (Bruner, 2021; Bruner, in press).

The Nature of New Words in Picture Books

Although researchers frequently target children's vocabulary growth as an outcome in studies of interactive read alouds, they rarely give attention to the nature of the words in books. In fact, van Kleeck (2003) declared this to be an ignored dimension in the adult-child-book triad, as have other researchers (DeTemple & Snow, 2003; Dickinson, McCabe, & Anastasopoulous, 2003; Mesmer, 2016; Zevenbergen & Whitehurst, 2003). For instance, DeTemple and Snow (2003) concluded that there has been relatively little work done on the impact of books with different lexical inventories. In other words, little research has examined how important it is to have the "right books" available for children, to select books that introduce certain types of words, or how caregivers and early childhood educators can make informed decisions about which texts provide optimal vocabulary exposure. Likewise, Zevenbergen and Whitehurst (2003) called for more research that focuses on what factors account for the variability found in studies of interactive read alouds, including how the

text and the words contained within them might relate to what children learn from these experiences.

One recent study that looked closely at words in print books written for preschool-aged children is Mesmer (2016), who identified new words in a sample of 108 books found in 30 preschool classrooms. Mesmer compared the words found in the sample texts against the Dale-Chall list (Chall & Dale, 1995), a list of 3,000 words that teachers have judged are known by at least 80 percent of all fourth graders. Using this method, the author identified a total of 228 new words in the sample books, for an average of 3.41 new words per book (SD=3.32). Approximately 19 percent of the books did not contain any new words, and another 20 percent contained five or more. This suggests that texts vary considerably in terms of the amount of new vocabulary they might offer children, which replicates findings from previous studies of preschool texts (Beals and Tabors, 1995; Weizman & Snow, 2001).

Using Mesmer (2016) as a guide, I conducted my own study of 60 preschool books from two children's book publishers: Scholastic and All About Books. While Mesmer looked closely at books found in preschool classrooms, my goal was to examine print books that are likely to be found in children's homes. The major difference between the Mesmer study and my own was the method used to identify new words. While the Dale-Chall list (Chall & Dale, 1995) is one of the most popular and enduring methods for identifying new words from texts (Beals & Tabors, 1995; Weizman & Snow, 2001; Rowe, 2012; Dickinson, Hofer, Barnes, Grifenhagen, 2014), it is problematic in contemporary studies of preschool books for two reasons. First, the list is more than 25 years old and does not account for the evolution of new words that are familiar to children today (e.g., podcast; hoverboard; ringtone). Second, and perhaps even more importantly, the Dale-Chall list (Chall & Dale, 1995) was created by asking teachers to judge which words were likely to be known by fourth-grade students. Certainly, a nine-year-old has words in their vocabulary that the

average four-year-old would not. Therefore, the Dale-Chall list (Chall & Dale, 1995) may highly overestimate the number of new words in books known by preschool children.

As such, I relied on the Words Worth Teaching List, a list of 11,000 root words likely to be encountered in elementary school. This list, developed by Biemiller (2009), rates root words based on children's age of acquisition. These words are categorized into groups that teachers can use as a guide to select words for vocabulary instruction. These groups are (1) easy words, or those that are known by most children at the end of second grade and typically do not require instruction; (2) words to teach before second grade, which are known by 40-80 percent of children by the end of Grade 2; (3) words to teach before Grade 6, which are known by 40-80 percent of children by the end of sixth grade; and (4) difficult words, known by fewer than 40 percent of children by the end of Grade 6. This list has been tested in a prior study of word learning in preschool classrooms, where it was found that children commonly knew the "easy" words, yet most of the words in other categories were still largely unfamiliar (Grifenhagen, 2012). Therefore, I compared every word from each book against the "easy" words on the Words Worth Teaching List (Biemiller, 2009). I expanded this list to include all inflected forms of the root words ('s, -s, -es, -ies, -d, -ed, -ied, -ing, -r, -er, -est, -ier, and -iest) which resulted in a list of 7,875 total words. If a word did not appear on the "easy" list or the list of inflected words, I considered it a new word for preschool-aged children.

Using this method, I found that 6.87 percent of the words in the sample books might be considered new words for children of this age (SD=0.04). Cumulatively, the books contained a total of 939 new words, with 649 unique word types. The number of new words per book ranged from a low of zero (n=2) to a high of 63 unique new words. On average, each text contained 10.77 new words (SD=10.56), with a median of 8 words per book. All but two texts contained at least one new word and 70 percent contained five or more. Like Mesmer (2016), this finding suggests that preschool texts vary considerably in the number of new words they introduce to children.

16

In summary, these two studies provide insights into the number of opportunities preschool children have to learn new words from print books and the methods used to identify new words in texts written for children of this age. In this study, I build upon these findings by identifying the number of word learning opportunities in one type of digital texts – preschool storybook apps – by using the Words Worth Teaching List (Biemiller, 2009) to define what constitutes a new word for preschool children. Additionally, I identify preschool storybook apps that are particularly rich in word learning opportunities, with the goal of supporting caregivers and early childhood educators to make informed decisions about which apps provide optimal vocabulary exposure.

Word-Level Features and Preschool Texts

Studies have shown that word-level features (e.g., concreteness, imageability, frequency) can impact the ease with which children may acquire new vocabulary (Elleman et al., 2017; Hiebert, 2019; Nagy & Hiebert, 2011; Cervetti, et al., 2015). Yet, few studies have examined and described the types of words children might learn from preschool texts. One factor that might influence how easily a word might be learned is the word's part of speech. Several studies have found that concrete nouns are relatively easier for young children to learn than other parts of speech, such as adjectives or adverbs (Beck & McKeown, 2001; Elley, 1989; Goodman, Dale, & Li, 2008; McDonough et al., 2011). For instance, in an experimental study with 178 second graders, Elley (1989) found that students learned significantly more nouns from interactive read alouds than other word types.

In her study of books found in preschool classrooms, Mesmer (2016) found that most new words were nouns (47 percent) (e.g., eggplant; anemone; core), followed by adjectives (29 percent) (e.g., ferocious; soggy; enormous), and verbs (17 percent) (e.g., create; mutter; disguise); five percent were adverbs (e.g., gently; firmly; bubbly), and less than one percent were conjunctions (e.g., nor) or pronouns (e.g., thee). I found similar results in my study of preschool books found in children's homes: most of the new words were nouns (49 percent) (e.g., safari; thermos; carousel), followed by

17

verbs (30 percent) (e.g., interrupt; fidget; disturb), and adjectives (17 percent) (e.g., steady; precise; determined), while less than two percent were adverbs (e.g., regularly) or prepositions (e.g., towards). This suggests that while many new words in preschool texts might be relatively easier for young children to learn (i.e., nearly 50 percent of the new words in both studies were nouns), over half the words fall into categories that might be more challenging for children to acquire (i.e., verbs, adjectives, adverbs). As such, children may need more support around these types of words, such as child-friendly explanations from caregivers or supportive contexts from the texts themselves (e.g., images or interactive experiences).

Another factor that might influence children's acquisition of new vocabulary is the difficulty of the word. Studies have found that exposure to difficult words in the preschool years is related to better vocabulary outcomes later in elementary school (Weizman & Snow, 2001; Rowe, 2012). For instance, Weizman and Snow (2001) found that children who were exposed to more challenging word types at age five scored higher on standardized measures of vocabulary in both kindergarten and second grade. While determining the difficulty level of a word is both arbitrary and context-dependent, there are several frameworks for estimating difficulty that researchers have drawn from in previous studies: Beck, McKeown, and Kucan's (2002, 2008) Word Tiers; Biemiller and Slonim's (2001) Living Word Vocabulary (LWV) ratings; and the Words Worth Teaching List (Biemiller, 2009).

Using the Word Tiers (Beck et al., 2002, 2008) as a measure of word difficulty, Mesmer (2016) found that approximately half the new words in books found preschool classrooms were Tier 2 words while another 46 percent were Tier 3 words. Tier 2 words are those that can be easily assimilated into existing schemata, since children usually possesses a ready synonym (Beck et al., 2002, 2008). Tier 3 words, on the other hand, are those that require the building of new schemata or concepts, and as such, explaining these words typically requires examples, descriptions, and

18

illustrations (Beck et al., 2002, 2008). Interestingly, words at certain Tiers were more or less likely to be nouns, adjectives, or verbs. For instance, 84 percent of the words identified as Tier 3 were nouns, but Tier 2 words tended to be either adjectives (46 percent) or verbs (20 percent). In my study of preschool books found in children's homes, I relied upon the categories in the Words Worth Teaching List (Biemiller, 2009) as a measure of word difficulty. Most of the words fell into the second category: words to teach before second grade (65 percent). However, 25 percent fell into the third category (i.e., words to teach before sixth grade) and 10 percent fell into the fourth category: the most difficult words.

Finally, children are more likely to learn words that they hear more frequently in their everyday environment (Naigles & Hoff-Ginsberg, 1998; Bates, Dale, & Thal, 1995; Goodman, Dale, Li, 2008; Massaro, 2016). For example, Massaro (2016) found that the frequency with which children hear a word used in conversations with their caregivers was a stronger predictor of acquisition than imageability, iconicity, or parts of speech. Yet, like word difficulty, capturing the number of times a child hears a word over the course of time is difficult, as children live and learn in different environments. However, over the past two decades, there has been an increase in the number of adult-child interactions captured by researchers in language corpora. One of the largest databases of adult-child interactions is the Parental Frequency Corpus (PFC) from the Child Language Data Exchange System (CHILDES) (Han et al., 2005; MacWhinney, 2000; Wellman & Woolley, 1990), a collection of 2.57 million words used by adult caregivers in their speech to children. The conversations recorded in this database involve children who range in age from six months to seven years, with most children being three years old. The PFC is described as "a representative sample of the speech that children this age are typically exposed to (e.g., dinner table talks, free play activities, and storytelling)" (CHILDES, 2014, p.1), making it particularly appropriate for this analysis. The PFC lists 24,000 unique words that are rank ordered by the number of

occurrences in the database. Therefore, it is possible to use this database to determine the estimated frequency for which children might hear a particular word from a text at another point in time.

Using the Parental Frequency Corpus (Han et al., 2005; MacWhinney, 2000; Wellman & Woolley, 1990), Mesmer found that 49 percent of the new words in books found in preschool classrooms occurred four or less times in the database, while 70 percent occurred 12 or less times. In my study of preschool books in children's homes, I found similar results: 53 percent of the new words occurred 5 or less times, with only 10 percent of the new words occurring more than 100 times. These findings suggest that most of the new words in preschool texts are unlikely to be words children have encountered frequently in their everyday lives. This means that it is particularly important that children hear these words through read alouds of texts that contain them.

Notably, in my study of preschool books found in children's homes, I found that different types of books (i.e., narrative, informational, interactive, alphabet, and counting books) differ significantly across these three word-level variables. For instance, I found narrative and counting books include new words across all parts of speech, but other types of texts (i.e., informational, interactive, and alphabet books) contain new words concentrated in only one or two categories – typically nouns and verbs. Furthermore, counting books and informational texts have a higher percentage of difficult words than the other texts, whereas alphabet books and interactive texts contain significantly more words at lower frequency levels (i.e., words that used less often in children's everyday environment).

This finding is important as several researchers have identified variability in caregivers' interactions depending on the type of text read during interactive read alouds (Pellegrini, Perlmutter, Galda, & Brody, 1990; Sorsby & Martlew, 1991; Beals and Tabors, 1995; Neuman, 1996; Weizman & Snow, 2001) and it is possible that word-level factors might play a role in these differences. For example, Pellegrini, Perlmutter, Galda, and Brody (1990) found that caregivers interacted more with

their children while reading expository texts than narrative texts. Similarly, Neuman (1996) showed that text type (highly predictable, episodic predictable, and narrative) influenced the way caregivers interacted with their preschoolers during shared book reading. Specifically, Neuman (1996) found that the use of predictable text frequently led to the child reading along with the caregiver providing feedback (e.g., corrections and confirmations), while the use of narrative text was related to distancing types of statements and recall questions. Relatedly, Beals and Tabors (1995) found that different types of texts elicited different amounts of talk about rare words from caregivers when reading aloud with their preschool-aged children.

In summary, these studies show that word-level features (i.e., parts of speech, word difficulty, and frequency) can impact the ease with which children may acquire new vocabulary. Additionally, these studies identify the types of words children can learn from preschool books and the methods used to describe word-level features. Importantly, these studies also show that different types of preschool books vary significantly in the words they contain and the types of interactions they elicit from caregivers. In this study, I examine preschool storybook apps for these three word-level factors (i.e., parts of speech, word difficulty, and frequency) to describe the types of words children can learn from these texts. Furthermore, given the variability of word-level features between different types of texts, and the impact these differences might have on caregivers' interactions, I restrict my analysis to narrative storybook apps only.

Promoting Word Learning from Texts: The Role of Caregivers

Assuming a social-constructionist view of learning, interactive read alouds have the potential to foster children's vocabulary skills, particularly when caregivers use texts as an opportunity to talk with their children about words (Arnold et al., 1994; Whitehurst et al., 1988 Zevenbergen & Whitehurst, 2003; Senechal, 2006; Mol et al., 2008; Hindman, Skibbe, & Foster, 2014). From a social-constructivist perspective, interactive read alouds are most effective when caregivers actively

involve children in conversations while reading aloud. For instance, in their seminal study, Whitehurst and colleagues (1988) found that children whose caregivers asked questions and expanded on their utterances during read alouds had significantly higher scores on standardized measures of expressive and receptive vocabulary. Arnold and colleagues (1994) found similar results: children whose mothers were trained to ask open-ended questions and provide expansions while reading also had significantly better outcomes on standardized measures of vocabulary. Likewise, Mol and colleagues (2008) found a moderate relationship between dialogic reading and children's expressive and receptive vocabulary (Cohen's d=0.42; $SE = 0.06$; 95% CI= 0.30, 0.53; $p < .001$). Similarly, Hindman, Skibbe, and Foster (2014) found that children whose caregivers engaged in meaning-focused talk while reading aloud (i.e., highlighting new vocabulary, recalling or summarizing book content, or relating the book to the child's own experiences) had higher vocabulary skills overall. Furthermore, in several experimental studies, book reading without adult input was used as the control group, resulting in limited vocabulary learning – almost at the level of chance (e.g., Whitehurst et al. 1988). Notably, when adults do not provide any input during book reading, children may try to engage them by asking questions about the story (Mautte, 1990). This implies that children perceive book reading as a natural opportunity for interaction, and as such, supporting caregivers to foster this interaction takes advantage of this perception (Wasik, Hindman, & Snell, 2016).

However, despite the benefits it provides, studies have found that caregivers typically do not engage in shared conversations around texts without instruction and support (Huebner, 2000a; Huebner & Melzoff, 2005). Yet, the nature of caregivers' talk has a critical impact on what children learn from the text (Evans, Shaw, & Bell, 2000; Lonigan et al., 1999; Senechal et al., 1998). Research has identified several different types of meaning-focused interactions caregivers might engage in while reading. One type of talk, termed descriptive talk (also known as immediate, concrete, or

contextualized talk) involves discussing content that is immediately apparent in the text, such as describing the characters and/or actions in the story; labeling and discussing illustrations; or summarizing the text and/or recalling previous events in the story (Dickinson & Tabors, 2001; Hindman et al., 2008). Caregivers might also employ inferential talk (sometimes referred to as non-immediate, abstract, or decontextualized talk), which includes making predictions about what might happen in the text or relating the story to children's own experiences. Furthermore, caregivers might attempt to help children understand the story content by defining words or explaining other information that helps children make sense of the story (e.g., "turtles move really slow; that's why no one thought he was going to win the race").

Despite the relatively small sample size of most studies, the extant literature provides some insight into the relative frequency of these different types of caregiver interactions. Studies have found that caregivers primarily label and describe the pictures in books when reading aloud but typically do not engage in much inferential talk (Dickinson & Tabors, 2001; Evans, Reynolds, Shaw, & Pursoo, 2011; Hindman et al., 2008; Senechal, 2006). When caregivers do engage in inferential talk, they most often evaluate the story and predict (or ask their children to predict) what might happen next. In contrast, defining words and summarizing the story are relatively uncommon occurrences (Dickinson & Tabors, 2001; Evans et al., 2011; Hindman et al., 2008). For instance, Evans and colleagues (2011) found that caregivers discussed only 4.2 percent of all new words while reading aloud with their six-year-old children. When a word was discussed, caregivers provided a definition 43 percent of the time, with another 40 percent dedicated to asking whether their child knew the meaning of the word. With respect to how a word's meaning was conveyed, the most common strategies used by caregivers was to make a general comment that explained part of its meaning (25 percent) and to provide a definition (26 percent). Linking the word to information in the text occurred 21 percent of the time, whereas linking the word to the child's own experience was

23

rarer, at just nine percent. When multiple strategies were used to explain a word (16 percent of instances), most often a definition of the word was combined with linking the meaning to the child's experience or the pictures in the story (79 percent).

Like interactive read alouds of print texts, studies have found that children benefit more from digital media when caregivers engage in shared interactions around the content (Lauricella et al., 2016; Strouse, O'Doherty, & Troseth, 2013; Strouse & Troseth, 2014; Lauricella, Blackwell, & Wartella, 2017; Dore et al., 2018). For example, Strouse, O'Doherty, and Troseth (2013) trained caregivers to use dialogic questioning techniques while viewing storybooks on video with their children. Compared to the control group, whose caregivers did not receive the training, the children in the intervention group learned significantly more new words while viewing stories alongside caregivers who asked questions about the content. In another study, Strouse and Troseth (2014) found that when caregivers made connections between objects in a video and their real-life counterparts, children were more likely to demonstrate transfer of the new words from the video to reality. Finally, in a study involving 135 families reading digital texts, Dore and colleagues (2018), found that interacting with a story alongside a caregiver promoted children's comprehension more than reading with the audio narration alone. Taken together, these studies highlight the importance of interactive and social experiences for children to benefit optimally from digital media.

In summary, these studies show that caregivers' interactions during read alouds are crucial for children's vocabulary development. Furthermore, caregiver interactions are also an important component of children learning in multimedia and digital formats. Additionally, these studies identify the different types of talk caregivers engage in while reading with their children and provide insights into the relative frequency with which they might occur. As such, in this study, I explore whether interactive features closely aligned to new words in preschool storybook apps might prompt caregivers to talk about new words with their children. I also examine the different strategies

caregivers use to engage in word-related talk while reading aloud, and whether the amount and types of interactive features influence whether and how caregivers engage with new words in the text.

Promoting Caregiver Interactions: Print versus Digital Texts

Studies of caregivers' interactions during shared reading of digital texts often draw from related work on interactive read alouds of print texts. These studies frequently employ comparisons between adult-child interactions with traditional print books versus digital texts to determine how talk is influenced by different mediums and to draw conclusions about the effectiveness of digital texts for this purpose. Although research in this area is limited, studies have shown mixed results about how digital texts might influence caregivers' interactions with their children during read alouds.

Several studies that compare caregivers' interactions using print books versus digital texts have found that adults focus more on behavioral and technical aspects in the digital format than on story content. Comments on how to hold the iPad or how the electronic pages are turned dominate caregivers' talk during interactive read alouds with digital texts, with fewer instances of meaning-focused talk than when they share print books (Parish-Morris, 2013; Krcmar & Cingel, 2014; Munzer et al., 2019). For instance, in their experimental study of 56 adult-child dyads, Parish-Morris and colleagues (2013) found that adults used more behavior-related utterances (e.g., "stop pressing the buttons and listen to the story") than story-related utterances (e.g., "Look! Clifford jumped into the soup!") with their preschool-aged children as compared to traditional print books. Krcmar and Cingel (2014) reported similar findings: in their study of 70 caregivers interacting with their two- to five-year-old children in two different story mediums – traditional books and electronic iPad books – caregivers engaged in more format-related talk with the iPad books than in the traditional book condition, where they used more evaluative comments about the story content and asked their children more questions related to the text. Similarly, in their study of 37 adult-toddler dyads,

Munzer and colleagues (2019) found that adults and children spoke fewer words overall and in a less collaborative manner when reading electronic books compared to print texts; caregivers also asked less questions and made fewer story-related comments. Instead, caregivers made significantly more format-related comments and negative directives (e.g., "stop touching the screen") when reading texts in digital formats.

Conversely, several other studies have found digital texts promote greater amounts and higher-quality adult-child interactions during read alouds (Korat and Or, 2010; Korat, Shamir, Heibel, 2013; Troseth et al, 2020). For example, in their study of 90 adult-child dyads, Korat, Shamir, Heibel (2013) found that caregivers used higher levels of conversational support with their preschool-aged children while reading digital texts as compared to print books. When reading the digital texts, caregivers had significantly more instances of relating the story to their children's experiences, elaborating on story content, and discussing language and print while reading the text. Troseth and colleagues (2020) found similar results: an enhanced digital text encouraged significantly more adult-child talk as compared to a digital text without interactive enhancements, including the use of a wider range of words by both caregivers and their children. When using the enhanced digital text, significantly more of the caregivers' talk was about the book, and less was aimed at their children's behavior.

In one of the few studies that looked at word-related talk specifically, Korat and Or (2010) explored interactions between caregivers and their young children while reading stories in two different mediums – print books and digital texts – and with two types of books: commercial and educational. The sample consisted of 48 kindergarten children and their caregivers, who were randomly assigned to one of four groups: (1) reading the commercial print book, *Just Grandma and Me*; (2) reading the commercial electronic book, *Just Grandma and Me*; (3) reading the educational print book, *The Tractor in the Sandbox*; or (4) reading the educational electronic book, *The Tractor in the*

Sandbox. Adult-child dyads were videotaped in their home environment while reading the text in their assigned condition. Findings showed that the educational electronic book yielded greater amounts of word-related talk than the commercial electronic book and both print texts. The authors hypothesized that the educational book included more challenging words than the commercial book and that, furthermore, the electronic book contained interactive features that more closely aligned to the words in the story. Taken together, these two factors may have influenced caregivers to engage in more word-related talk than while reading the other three texts.

As evidenced by this study, one possible explanation for mixed findings in the research literature might be related to the congruence of the interactive features themselves. Most technology-enhanced stories are loaded with interactive features such as puzzles, memory tasks, visual or sound effects, dictionary functions, or picture labels that appear when a reader activates a hotspot (de Jong & Bus, 2003; Guernsey et al., 2012; Korat & Shamir, 2004). Since these features are available at any time (de Jong & Bus, 2003), they might interrupt the flow of the story or draw children's attention away from listening to a story being read aloud. Two major research summaries – a meta-analysis (Takacs, Swart, & Bus, 2015) and a literature search that compared outcomes with effect sizes (Zucker, Moody, & McKenna, 2009) – concluded that interactive features, broadly defined, have a negative impact on children's learning when they are incongruent with the stories' plot and main narrative. Incongruent interactivity includes features not aligned with the main story and that draw attention away from the text to games or other activities embedded within digital books. Incongruent interactivity was also negatively related to vocabulary scores in an analysis of kindergarten children reading digital texts over one school year (Christ et al., 2019). In contrast, studies have found that interactive features that support story content may have a potential advantage. Segers and colleagues (2006) found that an electronic book with games to explain story vocabulary was more beneficial for children's word learning than a teacher reading a story to them.

Similarly, Korat and Shamir (2008) showed that children reading electronic books with dictionaries improved their story-related vocabulary more than children reading electronic books without this feature. Likewise, Smeets and Bus (2014) found that children who read digital texts that included explanations of difficult words in the narration in the form of hotspots outperformed the children in the electronic story condition without interactive features to support word learning. While these studies looked at children's outcomes as opposed to caregivers' interactions, it is reasonable enough to suggest that the congruence of interactive features might influence adult interactions in similar ways. As such, several scholars (e.g Bus, Neuman, Roskos, 2020; Kurcirkova, 2019) have recently called for future studies in this area to examine specific aspects of digital story design that might support adult-child interactions, as well as more nuanced sociocultural influences which dovetail with the design features of individual e-books (Kurcirkova, 2019).

In summary, these studies show mixed results of the benefits of digital texts for promoting caregivers' meaning-focused talk during read alouds. One explanation for this might relate to how well the interactive features in digital texts are aligned to the story content. Studies examining children's story comprehension and word learning from digital texts have found benefits when the interactive features are congruent with the text. However, little research has explored how the congruence of interactive features might support caregivers' interactions while reading aloud. As such, in this study, I explore whether interactive features that are closely aligned to new words in preschool storybook apps might promote more word-related talk from caregivers. I also examine the different types of interactive features present in these apps and explore whether the amount and types of these features influence whether and how caregivers interact with new words.

The Present Study

While research indicates that educational media may provide a beneficial context for vocabulary gains in the preschool years (Marulis & Neuman, 2013; Segers et al., 2006; Korat and Shamir, 2008;

Smeets and Bus, 2014), no known studies have looked closely at the words children might encounter in preschool digital texts or the specific mechanisms unique to this context that draw attention to word learning experiences on screen. To that end, the purpose of this study is to examine one type of preschool digital text – interactive storybook apps – for the affordances they may provide for young children's vocabulary development. Specifically, my study seeks to understand (a) the degree to which preschool storybook apps introduce new vocabulary words to young children; (b) the types of words children can learn from these texts; (c) the degree to which interactive features in storybook apps highlight new words; and (d) to what extent interactive features closely aligned to the words in the story might promote caregivers' word-related talk while reading aloud. Therefore, I ask the following questions:

1. What percentage of words in preschool storybook apps might be considered new words for children of this age?

2. Of these new words, what are their features in terms of these three characteristics: parts of speech, frequency, and word difficulty?

3. To what degree do interactive features highlight new words in preschool storybook apps?

4. How might interactive features closely aligned to the words in storybook apps promote caregivers' word-related extratextual talk?

Summary

Research has shown a clear relationship between the home literacy environment and children's language and literacy skills during the preschool years. One avenue through which the home environment is believed to exert its impact on vocabulary development is through interactive read alouds, a context that often provides children with the opportunity to encounter words they have rarely or never heard before. However, the nature of read alouds in young children's homes is

evolving, and little is known about the number of opportunities children might have to learn new words from digital texts. Furthermore, studies have shown that word-level features, such as parts of speech, frequency of usage in children's everyday environments, and word difficulty can impact the ease with which children may acquire new vocabulary. Yet, few studies have examined and described the types of words children might learn in the digital environment. Finally, research shows that interactive read alouds are most effective for children's vocabulary development when caregivers use texts as opportunity to talk with their children about words. However, little is known about how interactive features closely aligned to new words in digital texts might promote these types of interactions. In this study, I address these gaps in the literature by examining the affordances of preschool storybook apps for young children's vocabulary development.

CHAPTER 3 – METHODS

Today, nearly 60 percent of families with children ages 0-8 engage in read alouds on a digital device at least once per day (Rideout & Robb, 2020), with 98 percent of families now owning either a smartphone or tablet (Rideout & Robb, 2020). This phenomenon, coupled with the indisputable benefits of children reading print books, necessitates a critical need to identify the affordances of digital texts for young children's vocabulary development. To address this need, I designed two separate but related studies. First, I conducted a content analysis (Hoffman et al., 2011; Krippendorff, 2013) of 70 best-selling preschool storybook apps to make inferences to the words preschool children might learn from these texts and the mechanisms unique to this context that might draw attention to word learning experiences on screen. Specifically, I examined (1) the percentage of new words in preschool storybook apps that might be considered new words for children of this age; (2) the types of new words in preschool storybook apps; and (3) the degree to which interactive features highlight new words in these texts. In the second study, I observed 39 families reading four different stories in two mediums: two print books and two interactive storybook apps. My goal for the second study was to determine to what extent interactive features in storybook apps might naturally prompt caregivers' word-related talk while reading aloud. In this chapter, I describe the methodology used in both studies. First, I describe the design and logic, units of analysis, sampling plan and rationale, and coding and data analysis for the first study. Then, I explain the design and logic, participants, data sources, and coding and data analysis for the second study. Finally, I discuss the limitations of the methodology.

Study 1: Word Learning Opportunities in 70 Preschool Storybook Apps

This study addresses three research questions: (1) What percentage of words in preschool storybook apps might be considered new words for children of this age? (2) Of these new words, what are their features in terms of these three variables: parts of speech, frequency, and word

difficulty? and (3) To what degree do interactive features highlight new words in preschool storybook apps? In the sections that follow, I describe the design and logic, units of analysis, sampling plan and rationale, and coding and data analysis used to address these research questions.

Design and Logic

In the first study, I employ a content analysis methodology (Hoffman et al., 2011; Krippendorff, 2013) to make inferences to the words preschool children might learn from storybook apps. Krippendorff (2013) defines content analysis as "a research technique for making replicable and valid inferences from texts to the contexts of their use" (p.24). This methodology can use both quantitative and qualitative techniques (Neuendorf, 2002), and it aligns with my overarching goal to understand the affordances of preschool storybook apps for young children's vocabulary development. According to Krippendorff (2013), every content analysis has six components: (1) a defined unit of analysis; (2) a sampling plan and rationale; (3) an enacted plan for coding; (4) ways of reducing data into manageable representations (analysis); (5) inferences from the texts to the context (significance); and (6) a narrative of answers to the research questions. In this section, I will detail the first five components of my content analysis; the last section – a narrative of answers to the research questions – is provided in the next chapter.

Units of Analysis

The data source for this study is a sample of storybook apps designed for preschool-aged children from three popular app stores: Apple App Store, Google Play, and the Amazon App Store. Storybook apps present a fusion of written text, visuals, audio, and interaction design and are primarily designed for touchscreen devices such as mobile tablets and smartphones (Sargeant, 2015). Compared to mouse-operated computers, the easy touch-based operational features of these devices (e.g., tap, slide, swipe) make it intuitive for children to use and are convenient due to their portability and size (Neumann, 2020). There are approximately 197 preschool storybook apps available through

the Apple App Store, 65 available through Google Play, and 75 available through the Amazon App Store. While there is considerable overlap between the storybook apps available through each store, some apps are only available through only one store or another.

Sampling Plan and Rationale

To develop a representative understanding of new words in preschool storybook apps, I collected the Top 50 paid and Top 50 free apps listed in the "books" or "education" sections from all three stores over a six-week period in November and December 2020. Additionally, I obtained lists of highly rated or awarded apps from Common Sense Media, Parents' Choice Awards, and Children's Technology Review. Combined, these methods yielded a total of 123 storybook apps. Since storybook apps range widely in both content and design, I applied the following inclusion and exclusion criteria as detailed below.

To be included in the study, storybook apps had to meet all the following criteria:

- The storybook app is designed for preschool children ages 3-5

- The storybook app displays the text of the entire story

- The storybook app is developed in English

- The story component is the primary purpose of the app (i.e., the app is not a language or literacy game with a story embedded within it)

- The storybook app is written in the narrative genre

The following storybook apps were excluded from the study:

- Storybook apps where the text is not visible for all or part of the story (i.e., a narrator is reading the text, but it is not displayed for the reader to follow along)

- Storybook creation apps (i.e., the purpose of the app is to help children write their own digital stories)

- Religious-based storybook apps

- Holiday-themed storybook apps

- Choose-your-own adventure storybook apps

- Storybook apps where part of the story is free, but the remainder requires purchase

- Apps that contain multiple storybooks where children can play games for free but the stories themselves require purchase

- Apps with multiple storybooks where one story is free, but the rest require purchase or subscription

This sampling method resulted in a final list of 70 preschool storybook apps. Please see Appendix A for a full list of storybook apps identified through this sampling process.

Coding and Data Analysis

In the following section, I describe the procedures for coding and data analysis in four parts: one describing the preparation of the sample storybook apps for analysis and three describing the procedures for coding and analysis by research question. This is necessary given that each research question requires a different method for coding and analysis.

Sample Preparation

Following the sampling procedures, my first step was to obtain each storybook app and transcribe the full text of each story, starting from the first word and ending with the last word on the final page. Prior to coding, I removed the following types of words: proper nouns, onomatopoeia (e.g., cluck; plop; thump), expressions (e.g., Ooops!), invented words (e.g., grumpfish; oobleck), numerals (e.g., 100), and words in other languages (e.g., bon voyage; c'est bon), all of which would be flagged as new vocabulary words for preschool children. Furthermore, I removed three additional types of words and phrases during the coding process: hyphenated words (e.g., wind-powered; long-haired; medium-sized); two- and three-word phrases that cannot be separated without losing meaning (e.g., global warming; solar panels; hot air balloon); and slang words and

phrases (e.g., to no end; sound asleep). This is because the methods used to describe the word-level features can only use single words.

Research Question 1: Percentage of New Words in Preschool Storybook Apps

My goal for the first question was to describe the percentage of words in each storybook app that might be considered new vocabulary words for preschool-aged children. To define what constitutes a "new word" for children of this age, I relied on the Words Worth Teaching List, a list of 11,000 root words likely to be encountered in elementary school. This list, developed by Biemiller (2009), rates root words based on children's age of acquisition. These words are categorized into groups that teachers can use as a guide to select words for vocabulary instruction. These groups are (1) easy words, or those that are known by most children at the end of second grade and typically do not require instruction; (2) words to teach before second grade, which are known by 40-80 percent of children by the end of Grade 2; (3) words to teach before Grade 6, which are known by 40-80 percent of children by the end of sixth grade; and (4) difficult words, known by fewer than 40 percent of children by the end of Grade 6. This list has been tested in a prior study of word learning in preschool classrooms, where it was found that children commonly knew the "easy" words, yet most of the words in other categories were still largely unfamiliar (Grifenhagen, 2012).

As such, I compared every word from each storybook app against the "easy" words on the Words Worth Teaching List (Biemiller, 2009). I expanded this list to include all inflected forms of the root words ('s, -s, -es, -ies, -d, -ed, -ied, -ing, -r, -er, -est, -ier, and -iest) which resulted in a list of 7,875 total words. If a word appeared on the "easy" list or the list of inflected words, I considered this a "known" word for preschool-aged children; if a word appeared in the other three categories (i.e., words to teach before second grade; words to teach before Grade 6; or the "difficult" words), I considered it a new word for preschool-aged children. Finally, if a word did not appear in any category of the Words Worth Teaching List (Biemiller, 2009), I excluded the word from the analysis.

Since the storybook apps in the sample ranged in length from 37 words to 1,473 words, I established a percentage of new words in each text by dividing the number of new words by the total number of words in the text, excluding the words removed from coding. If a new word appeared more than once in the text, I counted it each time it appeared.

An example of this coding process is below. The words in bold font indicate those that would be identified as new words using the methods described above; the words in brackets indicate words I removed from coding. The excerpt below is taken from the storybook app, *Even Monsters Get Sick*, written and illustrated by Michael Bruza:

My name is [Harry], and one day I traded: [3] stickers, [2] sticks of gum, and [1] **skateboard** for [Mona's] pet monster named [Zub]. I thought it was a good trade because monsters are fun, but [Mona] said [Zub] was **lazy** and boring. Before I took [Zub] home, I had to **disguise** him because moms and dads on my street are afraid of monsters. But not me and my friends. We know that all monsters really need is lots of love and a good home.

Table 1

Example Coding Procedures: Identifying New Words

Title	Number of New Words	Total Words	Percentage
Even Monsters Get Sick	3	76	0.039

I repeated this process for all 70 storybook apps in my sample. In addition to the percentage of new words in each story, I also recorded information about the app developer, platform (i.e., Apple, Android, or both), price, the total number of unique words, story length, Lexile range, and the story content (i.e., whether the storybook app originated as a print book). Data analysis consisted of summarizing descriptive data related to the overall percentage of new words. Additionally, I used the story-level variables to conduct analysis exploring the differences in word

learning opportunities between storybook apps at different price points; their availability through different platforms; and the story content.

Research Question 2: Describing New Words in Preschool Storybook Apps

While the number of word-learning opportunities is an essential component of this study, exploring the types of words preschool children can learn from interacting with storybook apps is also an important element to consider. To do this, I examined three word-level features: parts of speech, frequency, and word difficulty.

First, to determine the part of speech of each new word, I checked each one against the dictionary entry for the word, taking special care to ensure the correct context. Second, to determine the frequency of each word, I relied on the Parental Frequency Corpus (PFC) from the Child Language Data Exchange System (CHILDES) (Han et al., 2005; MacWhinney, 2000; Wellman & Woolley, 1990) a database of 2.57 million words used by families and caregivers in their speech to children. The children in this database range in age from six months to seven years, with most children being between three- and five-years-old. The PFC is described as "a representative sample of the speech that children this age are typically exposed to (e.g., dinner table talks, free play activities, and storytelling)" (CHILDES, 2014, p.1), making it particularly appropriate for this analysis. This database rank orders the number of times (per 2.57 million words) a particular word was used between caregivers and children. For instance, the most frequently occurring word in the database is the word *you*, which appears 124,219 times; by comparison, words such as *yacht, verify*, and *splatter* occur only once. For each new word, I located it in the Parental Frequency Corpus (PFC) (Han et al., 2005; MacWhinney, 2000; Wellman & Woolley, 1990) and recorded the value; if the word did not appear in the database, I counted it as "zero." I excluded homographs (i.e., words such as *pound* and *row* that are spelled the same but differ in meaning or pronunciation) from this analysis. This is because it is not possible to tell the context of the word in the database.

Third, to determine the difficulty level of each word, I relied on the categories from the Words Worth Teaching List (Biemiller, 2009). As mentioned earlier, this list categorizes words into four groups: (1) easy words; (2) words to teach before second grade; (3) words to teach before sixth grade; and (4) difficult words, known by fewer than 40 percent of children by the end of Grade 6. I located each new word on the Words Worth Teaching List (Biemiller, 2009) and recorded the difficulty level. An example of this coding process is shown below in Table 2.

Table 2

Example Coding Procedures: Identifying Features of New Words

Word	Parts of Speech	Frequency	Difficulty
disguise	verb	4	T6
until	preposition	838	T2
gurgled	verb	0	T2

I repeated this process for each new word in every storybook app. In addition to the word-level variables, I also recorded information about the app developer, platform (i.e., Apple, Android, or both), price, and story content (i.e., whether the storybook app originated as a print book). Data analysis consisted of summarizing descriptive data related to the three word-level features. Additionally, I used the story-level variables to explore differences in words between storybook apps at different price points and their availability through different platforms.

Research Question 3: Interactive Features in Preschool Storybook Apps

One key distinction between storybook apps and traditional print books are the interactive features available on touchscreen devices. In this question, I explored the interactive features aligned to the new words in each storybook app. To do so, I used a framework developed by Danielson, Wong, & Neuman (2019) in their content analysis of new words found in preschool educational

media. In this study, the authors identified three theoretically informed categories of screen-based pedagogical supports: explicit definitions, visual effects, and attention-directing cues. The original coding scheme developed by Danielson, Wong, and Neuman (2019) is detailed below in Table 3.

Table 3

Codebook of Screen-Based Supports in Preschool Television Media

Label	Description
Explicit Definitions	Explicitly states the definition of the vocabulary word (Carlo et al., 2004; Lugo-Neris et al., 2010).
	Discusses features, gives examples, or tells the category of the vocabulary word (Collins, 2010; Lugo-Neris et al., 2010).
	Uses another language to define the vocabulary word (Collins, 2010; Gersten & Baker, 2000).
Visual Support	Uses a visual image of the word or visual effect around the word (Paivio, 2008; Takanishi & Le Menestrel, 2017).
	Demonstrates the function of the vocabulary word (Neuman, 2009; Takanishi & Le Menestrel, 2017).
Viewer Attention and Interaction	Says something or points to something to get viewers' attention (Silverman & Hines, 2009; Verhallen et al., 2006).
	Uses sound effects to get viewers' attention (Silverman & Hines, 2009; Verhallen et al., 2006).
	Repeats the vocabulary word three or more times to get viewers' attention (Baker et al., 2006; Hammer et al., 2014).
	Asks viewers to participate and/or engage with the vocabulary word (e.g., guess the word; repeat the word after a character; copy an action) (Restrepo et al., 2013).

I used this coding scheme as a starting point but adapted it to better align to the interactive features found in preschool storybook apps. For instance, I created a fourth category called *labeling*, which does not appear in the original coding scheme. I also collapsed some of the original categories, as some of the screen-based supports found in television programs were not present in storybook apps. For example, none of the storybook apps in my sample gave explicit definitions for vocabulary words. Table 4 shows the coding scheme I adapted for my study.

Table 4

Codebook of Interactive Features in Storybook Apps

Label	Description
Labeling	A narrator says the name of a picture on the screen after the reader taps on it.
	A narrator reads a word in a sentence out loud after the reader taps on it.
Explicit Definitions	Discusses features, gives examples, or tells the category of the vocabulary word (Collins, 2010; Lugo-Neris et al., 2010).
Visual Support	Uses a visual image of the word or visual effect around the word (Paivio, 2008; Takanishi & Le Menestrel, 2017).
	Demonstrates the function of the vocabulary word (Neuman, 2009; Takanishi & Le Menestrel, 2017).
Viewer Attention and Interaction	Says something or points to something to get viewers' attention (Silverman & Hines, 2009; Verhallen et al., 2006).
	Asks viewers to participate and/or engage with the vocabulary word (e.g., guess the word; repeat the word after a character; copy an action) (Restrepo et al., 2013).
	Uses visual effects around the word in the text (Takanishi & Le Menestrel, 2017)

The first category, definitions, included two types of interactive features. Reflecting the literature on word learning, the features in this category provided readers with rich demonstrations or examples of words (Collins, 2010; Lugo-Neris et al., 2010). For example, in the storybook app *My Little Pony Best Pet*, the character, Applejack, demonstrates the meaning of the word *wondered* by turning to another character and saying, "Does she understand what a pet really needs?" In another storybook app, *Goodnight Moon*, the reader can click on "the little old lady" and she gives an example of the word *whispering* by leaning forward and quietly saying "hush."

The second category, visual supports, included visual effects to scaffold a deeper understanding of vocabulary words (Silverman & Hines, 2009; Takanishi & Le Menestrel, 2017). For example, in *The Caterpillar and the Ladybug*, a leaf slowly falls from the top of the screen to the bottom, showing the reader what it means to *glide*. In another story, *The Icky Mr. Fox*, Mr. Rabbit walks from the left side of the screen to the right, showing the reader what it means to *stroll*. Interactive features in this category did not require an explicit definition to teach a vocabulary word, as images have the potential to teach vocabulary on their own.

The third category, labeling, included two types of interactive features that identified words for readers: (1) naming pictures on the screen (i.e., a reader can tap on a picture and the app "labels" the item for readers – either with a word that appears above the item or by saying the name of the item out loud), and (2) naming words in a sentence (i.e., a reader can tap on a word and the app reads the word out loud). For example, in *Tacky Goes to Camp*, the reader can tap on a picture of a pile of crumbs. The narrator says the word *crumbs* out loud, and the word *crumbs* appears above the picture. In another story, *My Little Pony: Cutie Pox*, the reader can tap on certain words in the text that are highlighted in purple font; after doing so, the narrator says the word out loud for the reader.

The final category, viewer attention and interaction, included three types of interactive features that engaged readers in word learning experiences: attention-directing cues (Silverman &

Hines, 2009), sound effects (Verhallen et al., 2006), and inviting the viewers to participate or engage with the vocabulary word (Restrepo et al., 2013). For example, in *Pat the Bunny*, the app invites the reader to engage with the word *inside*. The sentence in the text reads: Can you find out what's inside? Then, the reader can click on a toy and open it, revealing a new toy. Readers can repeat this process three times, with the narrator inviting readers each time to "touch the toy again to find out what's inside," until finally, a bunny appears. Features in this category were always coded in conjunction with another category because attention-directing cues may effectively draw viewers' attention toward specific words but do not necessarily teach viewers the meaning of the words.

To code the interactive features, I first located each new word in the storybook app and determined whether it was highlighted by an interactive feature in the text. If so, I used the coding scheme I adapted for this study to identify the types of interactive features that were present. Like the original coding scheme developed by Danielson, Wong, & Neuman (2019), a new word could be labeled with more than one feature. In addition to identifying the types of interactive features, I also determined whether readers are required to engage with the screen to activate it. In some cases, the interactive feature happens automatically (i.e., the reader does not need to touch the screen for it to happen); in other cases, the reader must tap on the screen to set the interactive feature into motion. An example of this coding process is shown below in Table 5.

Table 5

Example Coding Procedures: Identifying Interactive Features

Word	SBPS	Interaction	SBPS-Type 1	SBPS-Type 2	SBPS-Type 3
happened	No	.	.	.	.
twinkle	Yes	No	Viewer Attention	Visual Support	.
twitch	Yes	Yes	Visual Support	.	.

Furthermore, I also recorded information for each storybook app about the developer, platform (i.e., Apple, Android, or both), and price. Data analysis consisted of summarizing descriptive data related to the interactive features. Additionally, I used the story-level variables to conduct analysis exploring the differences in interactive features between storybook apps at different price points and their availability through different platforms. Furthermore, these interactive features serve as the focal point for the second part of this study, where I explore whether they might influence caregivers' word-related talk while reading aloud.

Study 2: Interactive Features and their Influence on Caregivers' Word-Related Talk

The second study investigates to what extent interactive features in storybook apps might help prompt caregivers to talk about words while reading aloud. This study addresses one research question: How might interactive features closely aligned to the words in storybook apps promote caregivers' word-related extratextual talk? In the sections that follow, I describe the design and logic, participants, data sources, and analytic strategies used to address this research question.

Design and Logic

The second study used an observational design to understand how interactive features might influence caregivers' word-related talk while reading preschool storybook apps out loud to their children. In this study, caregivers read four stories in two different mediums: two storybook apps and two traditional print books. Each adult-child dyad received both treatments using a counterbalanced approach; that is, caregivers read print books and storybook apps in different orders with the stories themselves also being rotated so each text was read in varying positions throughout the read aloud sessions (e.g., first or last).

Participants

Participants for this study included 39 families recruited through three avenues: free and low-cost preschool programs (e.g., Head Start), tuition-based preschool programs, and – to reach

43

families not currently enrolled in a preschool program – online parent listservs (e.g., the Michigan State University Parent Listserv). To be eligible for this study, at least one child in the home needed to be either four or five years old (not yet in kindergarten) with one adult available to complete all four read-aloud sessions. The adult-child dyad also needed access to a tablet (either Apple or Android), an internet connection (provided for free through local Head Start programs), and one other device to record video (e.g., a laptop computer with built-in camera; a mobile phone with a camera). Incentives for participating in the study included a $50 gift card and four preschool storybooks: two apps and two print books. Appendix B contains the recruitment flier shared with families through all three avenues. Institutional Review Board (IRB) approval was obtained from the host institution prior to recruitment and data collection.

Children in this study ranged in age from 48 months to 68 months (M=56.1, SD=5.6) with 56.8 percent of the children being female and 43.2 percent male. The caregivers who participated in the study were primarily the child's mother (83.8 percent), with the remainder of the adults being the child's father (16.2 percent). Approximately 73 percent of the caregivers were White, 11 percent Black or African American, 8 percent Asian, 5 percent two or more races, and 3 percent Asian/Pacific Islander. The highest education level completed by caregivers ranged from some college (10.8 percent) to a doctoral (24.3 percent) or professional degree (10.8 percent). All children and caregivers spoke English as their native language. The videos from two adult-child dyads were excluded from this analysis. In one instance, the audio was intelligible for large portions of one read aloud session; in the other instance, two different caregivers read the stories with their child, switching back and forth between stories during the same session. Table 6 provides details about the participants included in the analysis.

Table 6

Participant Background Information

Characteristic	Participants (*n*=37)
Child's Sex	Boy: 16 children (43.2 percent)
	Girl: 21 children (56.8 percent
Child's Age as of August 31, 2021	Range: 48 months – 68 months
	Mean: 56.11 months
	Median: 55.5 months
Caregiver's Relationship to Child	Father: 6 (16.2 percent)
	Mother: 31 (83.8 percent)
Highest Education Level Completed	Some college: 4 adults (10.8 percent)
	Four-year degree: 4 adults (10.8 percent)
	Master's degree: 16 adults (43.3 percent)
	Doctorate degree: 9 adults (24.3 percent)
	Professional degree: 4 adults (10.8 percent)
Caregiver's Ethnicity	White (non-Hispanic): 27 adults (73 percent)
	Black or African American (non-Hispanic): 4 adults (10.8 percent)
	Asian (non-Hispanic): 3 adults (8.1 percent)
	Two or more races (non-Hispanic): 2 adults (5.4 percent)
	Asian/Pacific Islander: 1 caregiver (2.7 percent)
Tablet used in Study	iPad (Apple): 25 (67.6 percent)
	Amazon Fire Kids (Android): 9 (24.3 percent)
	Samsung Tablet (Android): 3 (8.1 percent)

Data Sources

The data for the second part of this study came from two sources: one background survey distributed at the beginning of the study to each participant and 148 videos of read-aloud sessions

from the 37 adult-child dyads (four videos each). I conducted the second part of this study over a six-week period in August and September 2021. Followed by a description of the storybook selection procedures, I describe the data sources and the rationale for their use below.

Storybook Selection Procedures

I started by adopting storybook selection criteria by Hargrave and Senechal (2000) to identify texts to use for this study. The texts included narrative stories available through both platforms (i.e., Apple and Android), as families were invited to use a tablet of their choice to participate in the study. The storybook selection criteria were as follows: (a) contains colorful illustrations that help narrate the story; (b) contains vocabulary words in the text that are unlikely to be known by preschool-aged children; (c) are neither excessively long nor heavily reliant on text for telling the story; and (d) are developmentally appropriate (i.e., designed for children ages 3-5). Using these criteria as a guide, I first used Lexile text measures to select a set of texts written at equal readability levels. I chose 410L-610L as my starting point, because most of the storybook apps in my sample (52.9 percent) were written at this level. From there, I selected four stories with a similar percentage of new words in the text. I also looked for a similar percentage of these new words to be highlighted by interactive features. Table 7 provides a description of stories selected for this part of the study.

Table 7

Description of Storybook Apps Selected for Read Aloud Sessions

Title	Developer	Percent New Words	Percent Interactive Features	Lexile Range
Kalley's Machine Plus Cats	Rocket Wagon	12.1	21.2	410-600L
Even Monsters Get Sick	Busy Bee	9.6	20.0	410-600L
How I Became a Pirate	Oceanhouse Media	9.0	21.5	410-600L
My Little Pony: Best Pet	Playdate	11.6	28.6	410-600L

Following storybook selection procedures, I contacted the app developers who created each of the four storybook apps and obtained written permission to make print copies of the stories. After each developer granted permission to do so, I took screen shots of every page from each storybook app and compiled these images into four separate digital files. From these four digital files, I created print books for each storybook app to use in this part of the study. Developers gave permission for families to keep the print version at the conclusion of the study.

Participant Background Survey

At the beginning of the study, caregivers completed an electronic background survey which included demographic information, questions about their home literacy environment, and the type of tablet they planned to use throughout the study. The information from the background survey was used to describe the participants in my study and their experiences with both print and digital texts. I also used the information about their tablet to purchase apps for families ahead of the read-aloud sessions. Please see Table 6 for information about participants in the study and Table 8 for information about the participants' home literacy environment. Appendix C contains a copy of the participant background survey.

Table 8

Description of Participants' Home Literacy Environment

Characteristic	Participants (n=37)
Number of Print Books in the Home (Including Borrowed Print Books)	0-10: 0 families (0 percent)
	11-20: 0 families (0 percent)
	21-30: 2 families (5.41 percent)
	31-40: 2 families (5.41 percent)
	More than 50: 33 families (89.18 percent)

Table 8 (cont'd)

Characteristic	Participants (*n*=37)
Average Number of Days per Week Reading Print Books	My child doesn't look at picture books often: 0 families (0 percent)
	Once or twice: 1 family (2.70 percent)
	Three to six times: 6 families (16.22 percent)
	Every day: 30 families (81.08 percent)
	I'm not sure: 0 families (0 percent)
Child's Age: First Interacted with an App on a Tablet	Range: 6 months – 4 years (42 months)
	Average age: 27 months (2 years 3 months)
	Median age: 30 months (2 years 6 months)
Number of Digital Books in the Home (Including Borrowed Books)	0-10 books: 30 families (81.08 percent)
	11-20 books: 3 families (8.11 percent)
	21-30 books: 0 families (0 percent)
	31-40 books: 0 families (0 percent)
	41-50 books: 0 families (0 percent)
	More than 50 books: 4 families (10.81 percent
Average Number of Days per Week Reading Digital Books	My child doesn't look at digital books often: 27 families (72.97 percent)
	Once or twice: 7 families (18.92 percent)
	Three to six times: 3 families (8.11 percent)
	Every day: 0 families (0 percent)
	I'm not sure: 0 families (0 percent)

Video Recordings of Interactive Read Aloud Sessions

After the survey was completed, I sent each family an electronic calendar link to sign up for two 30-minute Zoom sessions at their convenience. I also assigned each family to one of eight counterbalanced conditions, shown in Table 9 below. To reduce attrition rates between sessions, I asked families to schedule times within one week of each other; families were also welcomed to

schedule back-to-back sessions if they preferred. Prior to the first session, I delivered the two assigned print books through several avenues based on families' preferences: mail; delivered in-person to campus and/or work addresses; delivered in-person to children's preschools; or delivered in-person to families' homes (i.e., left in their mailbox or on the porch). Two days before the first session, I sent each family an e-mail reminding them of their scheduled session times and included a $10 gift card to purchase the two assigned apps for their tablets (links to the stories in the corresponding app stores were included). For both the print books and the storybook apps, I asked families to wait until the read-aloud sessions to read the stories with their child.

Table 9

Storybook App Conditions: Counterbalanced Order

Condition	Text 1	Text 2	Text 3	Text 4
1	Story A (print)	Story B (app)	Story C (print)	Story D (app)
2	Story A (app)	Story B (print)	Story C (app)	Story D (print)
3	Story B (print)	Story A (app)	Story D (print)	Story C (app)
4	Story B (app)	Story A (print)	Story D (app)	Story C (print)
5	Story C (print)	Story D (app)	Story A (print)	Story B (app)
6	Story C (app)	Story D (print)	Story A (app)	Story B (print)
7	Story D (print)	Story C (app)	Story B (print)	Story A (app)
8	Story D (app)	Story C (print)	Story B (app)	Story A (print)

At the start of each 30-minute session, I asked both the child and the caregiver for permission to record the session. I then designated which two stories the families would read based on their assigned condition and asked families to read the stories in their typical fashion. Given the

49

uneven number of participants, two stories were read 18 times in storybook apps format, while the other two stories were read 19 times. Please see Table 10 for the number of times each story was read in print and digital formats. Once verbal permission was obtained and information about the session shared, I turned off my camera, started the recording, and caregivers began reading. I ended the recording once caregivers were finished reading both stories. For the families who scheduled back-to-back sessions, I offered a short break between the second and third story.

Table 10

Storybook Apps Read in Print and Digital Formats

	My Little Pony: Best Pet	Even Monsters Get Sick	Kalley's Machine Plus Cats	How I Became a Pirate
Print Book	19	18	18	19
Storybook App	18	19	19	18

Coding and Data Analysis

To examine whether interactive features influenced caregivers' word-related talk, I used the findings from the first part of the study to identify all the places where new words occurred in the four preschool storybook apps. Then, using this data as a guide, I viewed all 148 videos of the read aloud sessions and identified all the places in the videos where caregivers talked about new words with their children. I transcribed these marked episodes at the level of the utterance (i.e., units of speech bounded by breaths or pauses and conversational turns) (Neugebauer et al., 2017; Rex & Schiller, 2009). The transcripts identified the adults' talk (A) and, collectively, the child's talk (C). If no word-related talk occurred around the new words, I simply marked this spot in the video and transcribed the caregiver reading the text aloud. Additionally, I marked every place in the video where caregivers talked about any additional words that were not identified as "new" in the first part

of the study. Taken together, both sets of analysis allowed me to describe the types of words that caregivers talked about with their children as well as determine whether there was a significant difference in the number of words caregivers talked about in both mediums.

Once all utterances were coded, I entered all the data into a spreadsheet with the following information: the new word; the title of the story; the format (book or app); whether the word was highlighted by an interactive feature; whether the caregiver talked about the word; and, if so, the type of talk that occurred. An example of this process is shown below in Table 11.

Table 11

Example Coding Procedures: Identifying Caregivers' Word-Related Talk

Participant	Word	Story	Format	SBPS	Talk	Type-1	Type-2	Type-3
A	Strolling	MLP	Book	No	No	.	.	.
B	Strolling	MLP	App	Yes	Yes	Questions	Definition	Pictures
C	Strolling	MLP	App	Yes	No	.	.	.
D	Strolling	MLP	Book	No	No	.	.	.

To describe the strategies caregivers used to talk about words with their children, I used a researcher-designed coding scheme which I developed prior to the beginning of the study. This coding scheme, outlined in Table 12, is based on previous research on both dialogic reading strategies and word-related talk that caregivers typically engage in during read alouds. This coding scheme allowed me to describe the different ways caregivers talked about words with their children during the read aloud sessions, as well as make comparisons between the type of talk elicited by different types of interactive features.

Table 12

Coding Definitions and Examples of Caregivers' Word-Related Talk

Label	Definition	Examples
Definition of Word	The caregiver explains the meaning of the word to the child.	"Excited means you're very energetic and enthusiastic about whatever you're going to be doing."
Providing an Example	The caregiver gives the child an example of the word.	"Introduced. Say you meet new friends. Then someone who knows you both says, 'this is Gabriel,' and 'this is Max.' And that's how you get to know each other."
Pointing to a Picture	The caregiver points to a picture that illustrates the word in the text.	"Do you see this big puddle of green stuff under the monster? This is goo."
Asking Questions	The caregiver asks the child a question about the word.	"Do you know what strolling means?"
Expanding Utterances	The caregiver adds more information to what the child says.	"Yes, humongous means something is REALLY big!"
Making Connections	The adult connects the word to something the child already knows.	"Do you remember when we saw all the holiday lights blinking on the light posts downtown? Sometimes we call those 'twinkling lights.'"

Limitations to the Methods

There are several limitations to the methodology used in this study. First, while the Words Worth Teaching List (Biemiller, 2009) has been tested in a prior study involving preschool-aged children, it is important to challenge the assumption that words in the "easy" category are known by all children of this age. The "easy" designation itself is problematic, as children develop language on their own trajectories and in different environments. As such, an "easy" word for one child may not

be considered easy for another child. Furthermore, the Words Worth Teaching List (Biemiller, 2009) was created over 10 years ago, which means some words on this list are out-of-date today (e.g., afeared; ballpoint; bazooka). Alternatively, new words that have appeared in our everyday language within the past decade (e.g., ripple; podcast; hoverboard) are absent from this list. As such, these words were excluded from the analysis any time they appeared in the texts.

Second, I used the age designations provided by the app developers to determine whether each storybook app met the target age range for the study. In some cases, this means the storybook apps might be pitched too low for preschool-aged children. For instance, as a print book, the story *Pat the Bunny* (Kunhardt, 1940) is targeted to children ages birth to three, but as a storybook app, is designed for children ages 3-5. This might result in a larger number of words being designated as "known" during the coding process because the text was written with much younger children in mind. In other cases, the storybook app might be pitched too high for preschool-aged children. For example, the print book *Red Fox at Hickory Lane* (Hollenbeck, 2004), is written for children ages 4-9, but as a storybook app, is designed for children ages 3-5. As such, a greater number of words might be identified as "new" during the coding process because the text was written for older children.

Third, due to the methods used in this study, I excluded certain types of words and phrases: namely, hyphenated words (e.g., wind-powered; long-haired), two- and three-word phrases that cannot be separated without losing meaning (e.g., global warming; solar panels; hot air balloon), and slang words and phrases (e.g., to no end; sound asleep). I also excluded single words that did not appear in any category on the Words Worth Teaching List (e.g., artist; sunset; scientist). As a result, the number of word-learning opportunities in these storybook apps may be greater than what is reported here. In other words, the methods used to identify new words for preschool-aged children might be underestimating the number of words storybook apps introduce to children of this age.

Fourth, one of the overarching goals of this study was to explore whether interactive features might help prompt caregivers to talk about new words with their children while reading aloud. However, the caregivers in this study were primarily White (73 percent) well-educated mothers, with nearly 80 percent of caregivers holding a graduate degree, likely due the high response rate from the university-based parent listserv. Mothers with higher-SES backgrounds and higher levels of education tend to talk more to their children overall (Hoff, 2003b; Rowe, 2012) and typically use longer utterances with more diverse words in conversations with their children (Hoff, 2003a). This means the caregivers in my sample might already talk about words in books with their children more often than expected. Furthermore, nearly 90 percent of caregivers reported having more than 50 print books in their home, and 81 percent reported reading aloud to their children every day. Taken together, the results of this study might show a greater impact of interactive features, as well as more word-related talk in both conditions, due to the caregivers' demographics.

Finally, perhaps the greatest limitation of the study is that no child outcome data was collected. While several observational studies of adult-child read alouds do not include child outcome data (e.g., Huebner & Meltzoff, 2005; Landry et al., 2012; Munzer et. al, 2019), the absence of this information makes it difficult to evaluate whether the amount and type of caregivers' interactions impacted children's vocabulary development. Unlike observational studies that found correlations between caregivers' talk and children's word learning (e.g., Strouse, O'Doherty, & Troseth, 2013; Korat, Shamir, & Heibal, 2013; Strouse & Troseth, 2014), the relationship between caregiver talk and children's word learning from storybook apps has not yet been explored. The types of word-related talk identified here are aligned with research suggesting they would promote children's vocabulary development, but future research is needed to determine if this is the case.

Summary

This dissertation is comprised of two separate but related studies. In the first study, I examined 70 best-selling preschool storybook apps to make inferences to the words preschool children might learn from these texts and the mechanisms unique to this context that might draw attention to word learning experiences on the screen. In the second study, I observed 39 families reading four stories in two mediums: print books and interactive storybook apps, with the goal of determining to what extent interactive features might prompt caregivers to talk about words while reading aloud. In total, I examined 26,744 words in 70 best-selling preschool storybook apps and gathered nearly 2,340 minutes of observational data. To analyze this data, I used a combination of quantitative and qualitative techniques to examine opportunities for word learning in preschool storybook apps. I also used quantitative techniques to make within- and between-caregiver comparisons of word-related talk over the course of the study.

Given that caregivers are increasingly turning to digital texts to engage their children in read alouds at home, there is a critical need for research that examines the affordances of these texts for preschool children's vocabulary development. Therefore, the goal of this dissertation study was to examine best-selling preschool storybook apps to determine the extent to which they introduce new vocabulary words, the types of words children can learn from these texts, and the degree to which interactive features in storybook apps highlight new words. Furthermore, research clearly indicates that children need interactive and social experiences to benefit optimally from both print books and digital media (Lauricella et al., 2016). As such, the second goal was to determine the extent to which interactive features in storybook apps might promote caregivers' word-related talk. Taken together, this study addresses a timely and critical need to explore the potentials of preschool storybook apps for young children's learning environments.

CHAPTER 4 – PART 1 FINDINGS: RESEARCH QUESTIONS 1-3

The goal of the first study was to make inferences to the words preschool children might learn from preschool storybook apps and to describe the mechanisms unique to this context that might draw attention to word learning experiences on the screen. In this section, I report findings based on 26,744 total words found in 70 best-selling preschool storybook apps. The following research questions guided this study:

1. What percentage of words in preschool storybook apps might be considered new words for children of this age?

2. Of these new words, what are their features in terms of these three variables: parts of speech, frequency, and word difficulty?

3. To what degree do interactive features highlight new words in preschool storybook apps?

In this chapter, I first describe the 70 preschool storybook apps in my sample using six characteristics: story length, platform (i.e., Apple, Android, or both), app developers, story content (i.e., whether the storybook app originated as a print book), price, and Lexile ranges. Following this description, I share findings based on the percentage of new words in each storybook app, including key findings based on three storybook app characteristics: story content, platform, and price. Then, I describe the types of words children can learn from storybook apps using three word-level features: parts of speech, frequency, and word difficulty, and explore key findings about each feature based on platform and price. Finally, I explore to what degree interactive features highlight new words in preschool storybook apps with a focus on three characteristics: the percent of new words in each app highlighted by interactive features; the number of interactive features per word; and the most common type of interactive features used in preschool storybook apps.

Description of Sample Preschool Storybook Apps

In a content analysis (Hoffman et al., 2011; Krippendorff, 2013), it is important to understand the units of analysis to contextualize the overall findings from the study. As such, in this section, I describe the 70 preschool storybook apps that comprised my sample. To do so, I use six characteristics: story length, platform (i.e., Apple or Android), app developers, story content (i.e., whether the storybook app originated as a print book), price, and Lexile range. I first describe the purpose or importance of each characteristic and then share information based on each one.

Story Length

The more words in a story, the greater the opportunity children have to learn new words; a text with 1,000 words contains more words overall than a text with just 50 words. Furthermore, if five percent of the words in both texts are new words, that means there are 5 new words in the 50-word text and 50 new words in the 1,000-word text – a 900 percent difference. Longer stories also increase the amount of time caregivers and children spend interacting with the text, as it takes longer to read a story that contains more words. As such, I surveyed the length (in number of words) for each storybook apps in my sample. I also used this information to establish a percentage of new words in the texts in my first research question.

Table 13

Sample Preschool Storybook App Lengths by Quartiles

Percentile	Story Length
25th percentile	150 words
50th percentile	284 words
75th percentile	525 words
100th percentile	1473 words

Table 13 illustrates the average length (by quartiles) of the preschool storybook app in my sample. The storybook apps ranged in length from 37 words in *Oobie's Space Adventure* to 1,473 words in *The Cat in the Hat*. The average storybook app length was 382.1 words (*SD*=311). Given that the average oral reading rate for adults is 183 words per minute (Brysbaert, 2019) we would expect that these apps would take caregivers approximately 30 seconds to eight minutes to read aloud, assuming there is no extratextual conversations between the child and the caregiver. Therefore, storybook apps range broadly in both the number of words in the text and the amount of time it takes to read them out loud.

Platform

A secondary aim of this study is to explore the affordances of preschool storybook apps for increasing access to texts in communities that have been historically under-resourced. The preschool storybook apps in my sample were available on two platforms: Apple (i.e., through the Apple App Store) and Android (i.e., through the Amazon App Store or Google Play). While research shows that 98 percent of families now own either a smartphone or a tablet (Rideout & Robb, 2020), the price of these devices vary widely. When it comes to tablets, Apple products typically cost more than Android products. For instance, the most basic Apple iPad model – the iPad 9th Generation – costs $329, whereas a basic Amazon Fire 7 Kids Edition tablet (which runs Android) costs $59.99. Therefore, if access is important, it is essential to consider how the platform might impact the findings in this study.

To that end, 46 apps in my sample were available on both Apple and Android platforms (65.7 percent); 19 apps were available exclusively through Apple (27.1 percent); and 5 apps were available exclusively through Android (7.2 percent). This means that nearly 73 percent of preschool storybook apps are available on the lowest-priced tablets on the market. Therefore, families who purchase basic Android tablets – either out of necessity or by choice – can still access the majority of

the preschool storybook apps available. Please see Appendix A for a list storybook apps in the sample and their availability through each platform.

App Developers

Like the children's book publishing industry (Taxel, 2011), there are key players in storybook app creation as well. Table 14 describes the number and percentage of storybook apps in my sample created by each app developer. Twenty-one different developers created the preschool storybook apps in my sample. However, two main app developers dominated this group: Oceanhouse Media, which created 26 of the storybook apps (37.1 percent); and Loud Crow, which developed 15 storybook apps (21.4 percent). Only eight developers created multiple storybook apps in the sample, with the "author-created" label designating storybook apps that were designed by an individual author, not a developer (e.g., *Crepes by Suzette*, created by Monica Wellington). The remaining 12 developers created just one storybook app each. This means that most of the storybook apps on the market are created by just two developers.

Table 14

Number and Percentage of Sample Storybook Apps by Developer

Developer	Frequency	Percent	Cumulative
Oceanhouse Media	26	37.14	37.14
Loud Crow	15	21.43	58.57
Playdate	4	5.71	64.28
Author-Created	3	4.29	68.57
Icky Pen	2	2.86	71.42
Sesame Workshop	2	2.86	74.29
Busy Bee	2	2.86	77.15
Wee Society	2	2.86	80.01
OCG Studios	2	2.86	82.87

Table 14 (cont'd)

Developer	Frequency	Percent	Cumulative
Ayars Animation	1	1.43	84.29
VHS Design	1	1.43	85.73
Tinyvlog	1	1.43	87.16
Rocket Wagon	1	1.43	88.59
New Media Soup	1	1.43	90.02
Literary Safari	1	1.43	91.45
Random House	1	1.43	92.88
Sunbreak Games	1	1.43	94.31
Mofables	1	1.43	95.74
AKQA	1	1.43	97.17
Smartkids	1	1.43	98.6
Nickelodeon	1	1.43	100.00

Story Content

Storybook app developers are working in a space between technology design and children's book authors. However, in some cases, this duality is eliminated by using previously published print books as the basis for storybook app creation. Forty-six preschool storybook apps in my sample (65.7 percent) originated as a print book. For instance, the storybook apps in my sample include the highly acclaimed bedtime story, *Goodnight Moon* (Brown, 1947); the award-winning book, *The Kissing Hand* (Penn, 1993); and the classic children's story, *The Tale of Peter Rabbit* (Potter, 1901). The other 24 storybook apps (34.3 percent) were designed by app developers with original story content and created exclusively as an app; in other words, there is not a corresponding print version of the story. A few examples of these storybook apps include *Cat Alvin*, designed by Smartkids; *Cozmo's Day Off*, designed by Ayars Animation; and *Kalley's Machine Plus Cats*, designed by Rocket Wagon. I was

interested to see how these two approaches to storybook app design might impact my findings, hypothesizing that apps based on print books, whose authors are children's book writers by profession, might contain more new words as compared to storybook apps designed exclusively by app developers. Notably, the storybook apps created by Oceanhouse Media, the largest developer of storybook apps in my sample, were all designed based off a print book, as well as all but two storybook apps developed by Loud Crow, the second largest developer of storybook apps in my sample. Therefore, most of the storybook apps available on the market are based on previously published children's books, with fewer storybook apps containing original content.

Price Range

As mentioned above, if access is important, then it is essential to examine the cost of each storybook app. As such, I recorded the price of every storybook app in my sample and used this information as a variable to understand how apps at different price points compared in terms of the percentage of new words in the text, the types of words the text introduces to children, and the degree to which interactive features highlight new words in preschool storybook apps.

Table 15

Price of Sample Preschool Storybook Apps

Price	Frequency	Percent	Cumulative
$0	8	11.43	11.43
$0.99	8	11.43	22.86
$1.99	9	12.86	35.71
$2.99	27	38.57	74.29
$3.99	12	17.14	91.43
$4.99	3	4.29	95.71
$5.99	3	4.29	100.00

Table 15 shows the number and percentage of preschool storybook apps at each price point. The storybook apps in my sample ranged in price from free (8 apps) to $5.99 (3 apps). An one-way analysis of variance showed that the story length significantly impacted the price of storybook apps, $F(6,69)=5.83$, $p<.01$, with story length explaining over one-third of the variance (0.36). The average price of the storybook apps in my sample was $2.67 with a median price of $2.99. Notably, nearly 23 percent of the apps were either free or $0.99, with nearly three-fourths of the apps costing less than $3.00. Of the 56 apps in my sample that cost less than $3.00, 36 apps (69.2 percent) are available on both Android and Apple platforms, making them available to families regardless of the tablet they own. Notably, all the free storybook apps were created exclusively by developers with two or less storybook apps in the sample; only one developer, OCG Studios, had both a free app (*The Artist Mortimer*) and a paid app (*The Artist Mortimer 2*). Therefore, while storybook apps range in price from free to $5.99, many of the apps available cost less than $3.00 – with most of the free apps created by developers who are just getting started with storybook app creation.

Lexile Text Measures

The Lexile text measure calculates the complexity of a text by breaking down the entire piece and analyzing its characteristics, such as sentence length and word frequency, which represent the syntactic and semantic challenges that the text presents to a reader. Generally, texts with longer sentences and words with lower frequencies (i.e., words that occur less often in everyday conversations) have higher Lexile text measures, which means they are more challenging for readers to comprehend. By contrast, texts with shorter sentences and words with higher frequencies (i.e., words that are more common in everyday language) have lower Lexile text measures, which means they are relatively easier for readers to understand. I used Lexile text measures to identify how challenging the sample storybook apps might be for preschool children to comprehend during

interactive read alouds of these texts. I also used Lexile text measures in the second study to select storybook apps at similar readability levels for families to read aloud.

Table 16

Lexile Text Ranges of Sample Storybook Apps

Lexile Range	Frequency	Percent	Cumulative
210L-400L	14	20.00	20.00
410L-600L	37	52.86	72.86
610L-800L	14	20.00	92.86
810L-1000L	5	7.14	100.00

Table 16 illustrates the number and percentage of preschool storybook apps written at each Lexile range. The storybook apps in my sample had a Lexile range from 210L-1000L, which corresponds to texts written at kindergarten through eighth grade levels. Some examples of apps on the lowest end of the Lexile text range (210L-400L) include *Pat the Bunny*, developed by Randomhouse; *Five Little Monkeys Jumping on the Bed*, developed by Oceanhouse Media; and *Oobies Space Adventure,* developed by VHS Design. Alternately, apps at the highest Lexile text range (800L-1000L) included *Cozmo's Day Off*, designed by Ayars Animation; *The Caterpillar and the Ladybug*, developed by New Media Soup; and *The Tale of Benjamin Bunny*, designed by Loud Crow. Nearly three-fourths of the apps in my sample had a Lexile text range between 210L-600L, which corresponds to text written at a kindergarten through second grade level. Therefore, while storybook apps range broadly in Lexile range, most are written for children in the early elementary grades and contain shorter sentences and words with higher frequencies, making them relatively accessible to preschool-aged children.

In summary, these 70 apps comprised the sample in which I used to make inferences to the words preschool children might learn from storybook apps and to describe the mechanisms unique

to this context that might draw attention to word learning experiences on screen. In the next section, I share findings from my first research question, in which I examined the percentage of words in storybook apps that might be considered new for preschool-aged children.

Research Question 1: Percentage of New Words in Preschool Storybook Apps

The goal of the first research question was to describe the percentage of words in preschool storybook apps that might be considered new vocabulary words for children of this age. To define what constitutes a "new word" for preschool-aged children, I relied on the Words Worth Teaching List (Biemiller, 2009), a list of 11,000 root words likely to be encountered in elementary school. This list has been tested in a prior study of word learning in preschool classrooms, where it was found that children commonly knew the words in the "easy" category, yet most of the words in other categories were still largely unfamiliar (Grifenhagen, 2012). As such, I compared every word from each storybook app against the "easy" words on the Words Worth Teaching List (Biemiller, 2009). If a word appeared on the "easy" list or the list of inflected words, I considered this a word that preschool-aged children would know. Furthermore, if a word appeared in the other three categories (i.e., words to teach before second grade; words to teach before sixth grade; or the "difficult" words), I considered it a new word for preschool-aged children. Finally, if a word did not appear in any category of the Words Worth Teaching List (Biemiller, 2009), I excluded the word from the analysis. In this section, I share findings about the percentage of new words in preschool storybook apps. Additionally, I share key findings based on three storybook app characteristics: story content, platform, and price.

Percentage of New Words in Sample Storybook Apps

The first part of the analysis looked at the percentage of new vocabulary words in a sample of 70 best-selling preschool storybook apps. On average, 7.56 percent of the words in the sample apps might be considered new words for children of this age ($SD=0.03$). The percent of new words

ranged from 0.5 percent in the storybook app, *Five Little Monkeys Jumping on the Bed* to almost 15 percent (0.148) in the storybook app, *Sunny's Dark Night*. Table 17 shows the ten preschool storybook apps with the highest percentage of new words in the sample.

Table 17

Storybook Apps with the Highest Percentage of New Words

Title	Print Book	Platform	Price	Percent
Sunny's Dark Night	No	Android	2.99	14.8
Tacky and the Winter Games	Yes	Both	3.99	14.1
My Little Pony: The Movie	No	Both	2.99	13.5
Ooobie's Space Adventure	No	Apple	0	13.5
Cozmo's Day Off	No	Apple	0.99	13.5
My Little Pony: Cutie Pox	No	Both	2.99	13.4
Pete's Robot	No	Apple	0	13.0
Goodnight, Goodnight, Construction Site	Yes	Apple	3.99	12.4
Wee Alphas	No	Apple	2.99	12.2
Kalley's Machine Plus Cats	No	Both	0.99	12.1

Cumulatively, the sample apps contained a total of 1,970 new words with 1,376 unique new word types. The number of new words per app ranged from a low of one unique word, which occurred in just two storybook apps – *Blue Hat, Green Hat* and *Five Little Monkeys Jumping on the Bed* – to a high of 63 unique words in the storybook app, *My Little Pony: The Movie*. On average, each sample app contained 19.7 unique new words per story (*SD*=15), with of a median of 15 new words. Notably, every storybook app contained at least one new word, with nearly 83 percent of apps containing five or more. Table 18 illustrates the number of new words in the sample storybook apps by quartiles. This table also includes a list of all the new words in these four stories.

Table 18

Number of Unique New Words in Sample Storybook Apps by Quartiles

Title	Percentile	New Words	List of New Words
Byron Barton: Trains	25th	6	track, freight, puffing, must, town, speeding
The Caterpillar & the Ladybug	50th	15	tried, dare, tight, until, stretches, sigh, find, smoothly, glide soar, flit, whole, may, too, learn
The Kissing Hand	75th	32	edge, may, want, gently, strange, once, added, warm, cozy, tears, interested, kind, called, left, palm, tingled, warmth, check, very, toasty, thoughts, lose, worry, stick, thoughtful, suddenly, unfolded, familiar, too, gentle, limb, rang
My Little Pony: The Movie	100th	63	despite, setback, still, suddenly, problem, worst, strange, demands, surrender, turned, seek, help, hear, leader, vows, recapture, restore, search, beyond, called, charming, manor, discover, find, generosity, bond, daring, mountain, bold, inspire, exactly, stall, until, saved, trust, dread, pearl, part, caught, banish, blame, should, forgive, rally, cause, abandoned, real, control, staff, powers, sneak, hidden, tower, betrays, whole, unfortunately, yet, sacrifice, topple, helplessly, former, glory, reassure

Story Content: Impact on the Percentage of New Words

I hypothesized that apps based on print books – whose authors are children's book writers by profession – might contain more new words as compared to storybook apps designed exclusively by app developers, who have the dual responsibility of both writing content and designing the technology. However, apps designed with original content (*M*=0.09, *SD*=0.03) had a significantly higher percentage of new words than apps based on a print book (*M*=0.06, *SD*=0.03), *t*(68)=3.39, *p*<.01, *d*=0.85. Notably, the apps developed by Oceanhouse Media, the largest developer of storybook apps in my sample, were all designed based off a print book, as well as all but two storybook apps developed by Loud Crow, the second largest developer of storybook apps in my sample. As Table 13 illustrates, most of the storybook apps on the market with the highest percentage of new words are created with original content by app developers who have written only one or two stories.

Price: Impact on the Percentage of New Words

One of the secondary aims of this study was to examine the affordances of preschool storybook apps for increasing access to texts. Notably, free and $0.99 apps (*M*=0.09, *SD*=0.03) contained a similar percentage of new words as apps priced higher than $1.00 (*M*=0.07, *SD*=0.04), *t*(68)=1.41, *p*=.163. This finding holds true for storybook apps priced below $3.00 as well: apps priced lower than $2.99 (*M*=0.08, *SD*=0.01) also contained a similar percentage of new words as apps priced above $3.00 (*M*=0.07, *SD*=0.01), *t*(68)=0.94, *p*=.353. Taken together, these findings suggest that free and low-cost storybook apps give children access to a similar percentage of new words as apps at higher price points.

While this finding has important implications for children's access to texts, it is important to remember that the price of the storybook apps in my sample were significantly impacted by the length of the story itself. For instance, *Oobie's Space Adventure*, a free storybook app with the fourth-

highest percentage of new words, was also the shortest story in the sample, at just 37 words. While the percentage of new words is among the highest in the sample, due to the length of the story, it only amounts to five new words. On the other hand, *Tacky and the Winter Games*, which is just ahead of *Oobie's Space Adventur*e with the second highest percentage, has 78 total new words – 49 of them unique. By comparison, *Tacky and the Winter Games* is 15 times longer at 555 words and costs $3.99. So, while free and low-cost storybook apps offer a similar percent of new words as apps at higher price points, they typically introduce less new words overall.

Platform: Impact on the Percentage of New Words

Given that an important aim of this study is exploring the affordances of preschool storybook apps for increasing access to texts, it is important to consider how the platform the apps are available on (i.e., Apple or Android) might impact the percentage of new words in the story. When it comes to tablets, Apple products typically cost more than Android products. However, apps available through Android or both platforms (M=0.07, SD=0.03) contained a similar percentage of new words as apps available exclusively through Apple (M=0.08, SD=0.03), t(68)=0.98, p=.329. Therefore, families do not need access to Apple products – which tend to be significantly more expensive – to download storybook apps with a high percentage of new words in the text. In fact, the storybook app, *Sunny's Dark Night*, the app with the highest percentage of new words in the sample, is one of only five apps available exclusively through Android platforms (i.e., the Amazon App Store or Google Play). As illustrated in Table 13, half of the top ten storybook apps with the highest percentage of new words are available through Android or both platforms.

Yet, it is important to note that six out of the eight free apps – or three-fourths of all the free apps in my sample – are only available through Apple, as well as four out of eight of the apps available for $0.99. This means that the most inexpensive storybook apps in my sample are only available on some of the most expensive tablets on the market. However, of the 56 apps in my

sample that cost less than $3.00, 36 apps (69.2 percent) are available on both Android and Apple platforms.

Research Question 2: Describing New Words in Preschool Storybook Apps

The goal of the second research question was to describe the types of words children can learn from preschool storybook apps. In this section, I share findings based on three word-level features: parts of speech, word frequency, and word difficulty. Additionally, I explore how the price of storybook apps and the platform they are available on impact the types of words that children can learn from these stories.

Parts of Speech

One factor that influences how easily a word might be learned is the word's part of speech. Several studies have found that concrete nouns are relatively easier for young children to learn than other parts of speech, such as adjectives or adverbs (Beck & McKeown, 2001; Elley, 1989). However, children need exposure to all kinds of words to support later development in word recognition and reading comprehension. In fact, the Common Core State Standards (CCSS) expects that children can use the most frequently occurring nouns, verbs, and prepositions by the end of kindergarten, and use the most frequently occurring adjectives by the end of first grade (National Governors Association Center for Best Practices, 2010).

Most of the new words in the sample storybook apps were verbs (39.9 percent), followed by nouns (27.7 percent), and adjectives (16.7 percent). However, the sample apps also introduce children to new words across six other parts of speech: adverbs such as *suddenly, briskly*, and *quite*; modal verbs such as *would, should, must*, and *may*; prepositions such as *towards* and *until*; determiners such as *most, several*, and *millions*; conjunctions such as *once, unless*, and *nor;* and pronouns such as *whom* and *which*. Table 19 shows the types of words available in preschool storybook apps.

Table 19

New Words in Sample Storybook Apps by Parts of Speech

Parts of Speech	Number of New Words	Percentage	Examples
Verbs	550 words	39.89	introduced, pretend, install, stroll, stumbled, compete
Nouns	382 words	27.70	chute, creatures, mischief, destination, station, asteroid
Adjectives	216 words	15.66	thick, difficult, ferocious, familiar, courageous, delicious
Adverbs	125 words	9.06	suddenly, briskly, quite, gently, exactly, unfortunately
Modal Verbs	45 words	3.26	must, should, would, may, shall, might
Prepositions	40 words	2.90	around, until, among, since, towards, throughout, including
Determiners	10 words	0.72	such, most, several, millions
Conjunctions	6 words	0.44	once, unless, though, nor
Pronouns	6 words	0.44	whom, least, which, other

Word Frequency

Children are more likely to learn words that they hear more frequently in their everyday environment (Naigles & Hoff-Ginsberg, 1998; Bates, Dale, & Thal, 1995; Goodman, Dale, Li, 2008; Massaro, 2016). Over the past two decades, there has been an increase in the number of adult-child interactions captured by researchers in databases of spoken language. These databases can help us estimate the number of times children hear certain words in their environment. In this study, I relied upon the Parental Frequency Corpus (PFC) from the Child Language Data Exchange System

(CHILDES) (Han et al., 2005; MacWhinney, 2000; Wellman & Woolley, 1990), a database of 2.57 million words used by families and caregivers in their speech to children. The most frequently occurring word in the database is the word "you," which appears 124,219 times; by comparison, words such as *yacht, verify*, and *splatter* occur only once.

Approximately two-thirds (64.2 percent) of the new words from the sample apps occurred 50 or less times in the Parental Frequency Corpus (Han et al., 2005; MacWhinney, 2000; Wellman & Woolley, 1990). Notably, 13 percent of the new words did not occur at all. Some examples of the words that never appeared in the database, yet did appear in the storybook apps include *scurrying, inspire, exert*, and *generosity*. This means that of the 2.57 million words in the database, caregivers never used any of these words while speaking with their children. Given that many of the words from preschool storybook apps are unlikely to occur often in conversations with children, it is particularly important that we introduce these words through read alouds of texts that contain them. Table 20 illustrates the new words in storybook apps that occurred 50 or less times in the Parental Frequency Corpus (Han et al., 2005; MacWhinney, 2000; Wellman & Woolley, 1990).

Table 20

New Words in Sample Storybook Apps with Frequencies Less Than 50

Frequency	Number of New Words	Percentage	Examples
0 occurrences	125 words	13.01	scurrying, tempt, generosity, inspire, exert, daring
1-5 occurrences	249 words	25.91	confessed, participated, hearty, congratulated, scrolling, puzzled
6-10 occurrences	73 words	7.60	popular, satisfied, absolute, cozy, millions, aware

Table 20 (cont'd)

Frequency	Number of New Words	Percentage	Examples
11-25 occurrences	96 words	9.99	disappointed, among, ease, glory, unfortunately, keen
26-50 occurrences	74 words	7.70	pleased, wondered, somersault, within, doubt, realize

Word Difficulty

Some words are more difficult for children to learn for a variety of reasons, including several variables explored in this study: parts of speech and frequency. Determining the "difficulty" of a word is both arbitrary and context-dependent, but there are several tools that can help estimate how difficult a word might be for children to learn. In this study, I relied upon the categories in the Words Worth Teaching List (Biemiller, 2009). This list categorizes words into four groups: (1) easy words; (2) words to teach before second grade, which are known by 40-80 percent of children by the end of Grade 2; (3) words to teach before Grade 6, which are known by 40-80 percent of children by the end of sixth grade; and (4) difficult words, known by fewer than 40 percent of children by the end of Grade 6.

In terms of difficulty, most of the new words from the sample apps fell into the second category: words to teach before second grade (67.4 percent). However, approximately one-third of the new words fell into the two most challenging categories: words to teach before sixth grade (25.5 percent) and difficult words (7.1 percent). Some examples of the words that fell into the "difficult" category include *cavort*, *ferocious*, *elaborate*, *nonchalant*, and *aerodynamic*. Table 21 shows the percentage of new words across word difficulty levels.

Table 21

New Words in Sample Storybook Apps by Word Difficulty Levels

Difficulty Level	Number of New Words	Percentage	Examples
Words to teach before 2nd Grade	929 words	67.37	harsh, slippery, exactly, slumbered, embarrassed, suddenly
Words to teach before 6th Grade	352 words	25.53	disguise, sassy, thoughtful, aroma, trifle, abandoned
Difficult Words	98 words	7.11	dismay, promising, catapult, betray, obstinate, dreadfully

Relationship between Price and Word Features

While free and $0.99 storybook apps contain a similar percentage of new words as apps at higher price points, it is also important to examine how the price of the apps might influence the types of words children might learn from these stories. This is because children need exposure to all different types of words to become successful readers – and if access is important, then it is essential to ensure that apps at lower price points contain the full range of words available in the sample apps. Importantly, I found that free and $0.99 apps contained a similar distribution of new words across parts of speech as apps priced higher than $1.00, $X^2(9, N=1,379) = 5.68, p=.771$. In other words, free and $0.99 apps give children access to similar amounts of more challenging word types – such as adjectives, prepositions, and conjunctions – as apps priced higher than $1.00. Table 22 shows the distribution of parts of speech for free and $0.99 apps as well as apps priced higher than $1.00.

Table 22

New Words in Sample Storybook Apps: Parts of Speech Comparison by Price

Parts of Speech	Free & $0.99	More than $1.00	Total
Nouns	73 words	309 words	382 words
Verbs	106 words	444 words	550 words
Adjectives	30 words	186 words	216 words
Adverbs	24 words	101 words	125 words
Prepositions	8 words	32 words	40 words
Conjunctions	1 word	5 words	6 words
Determiners	1 word	7 words	8 words
Modal Verbs	10 words	35 words	45 words
Pronouns	0 words	6 words	6 words
Numbers	0 words	1 word	1 word
Totals:	253 words	1,126 words	1,379 words

Second, free and $0.99 apps (*M*=198.9, *SD*=420.5) contained new words with similar frequencies as apps priced higher than $1.00 (*M*=190.2, *SD*=420.5), $t(937)=0.25$, *p*=.802. Or, put another way, free and $0.99 apps contained a similar distribution of new words at both lower frequency levels (i.e., words that appear less often in everyday conversation) and higher frequency levels (i.e., words that appear more often) as apps priced higher than $1.00, $X^2(9, N=1,366)=14.11$, *p*=.118. This means that free and $0.99 storybook apps introduce similar amounts of uncommon words into children's everyday environment as storybook apps at higher price points. Table 23 shows the distribution of word frequency levels for free and $0.99 apps as well as apps priced higher than $1.00.

Table 23

New Words in Sample Storybook Apps: Frequency Comparison by Price

Frequency	Free & $0.99	More than $1.00	Total
0	22 words	103 words	125 words
1-5	41 words	208 words	249 words
6-10	11 words	62 words	73 words
11-25	15 words	68 words	83 words
26-50	16 words	58 words	74 words
51-100	15 words	58 words	73 words
101-250	27 words	66 words	93 words
251-500	1 word	21 words	22 words
501-1000	19 words	59 words	78 words
More than 1000	85 words	411 words	496 words
Total:	252 words	1,114 words	1,366 words

Finally, free and $0.99 apps contain a similar distribution of new words across word difficulty levels as apps priced higher than $1.00, $X^2(2, N=1,379) = 5.35, p=.07$. This means that free and $0.99 storybook apps introduce children to similar amounts of challenging words as storybook apps priced higher than $1.00. It is important to note here that "difficult" does not mean these words should be avoided because they are "too difficult." By reading texts with children during the preschool years that contain words such as these, we give them an advantage by introducing them to the types of challenging words they will encounter in texts throughout elementary school, boosting their comprehension and their ability to decode these words more quickly as they read. Table 24

shows the distribution across word difficulty levels for free and $0.99 apps as well as apps priced higher than $1.00.

Table 24

New Words in Sample Storybook Apps: Word Difficulty Comparison by Price

Difficulty	Free & $0.99	More than $1.00	Total
2nd Grade	186 words	743 words	929 words
6th Grade	52 words	300 words	352 words
Difficult	15 words	83 words	98 words
Total:	253 words	1,126 words	1,379 words

Taken together, free and $0.99 storybook apps introduce children to similar types of new words across parts of speech, word frequency, and word difficulty as apps priced higher than $1.00. This means that families with limited resources can still gain access to stories that introduce children to a range of challenging word types through free and $0.99 storybook apps. In the next section, I explore how the platform impacts the types of words children might encounter in preschool storybook apps.

Relationship between Platforms and Word Features

Given that Apple products – at $329 for the most basic iPad – are among the most expensive tablets on the market, it is also important to examine how the platform these apps are available on might impact the types of new words children can learn. First, apps available through Android or both platforms contain a similar distribution of new words across parts of speech as apps available exclusively through Apple, $X^2(9, N=1,379)=12.56, p=.184$. This means that apps available through Android or both platforms give children access to similar amounts of more challenging word types – such as adjectives, prepositions, and conjunctions – as apps available

exclusively through Apple. Table 25 shows the distribution of parts of speech for apps available through Android or both platforms as well as apps available exclusively through Apple.

Table 25

New Words in Sample Storybook Apps: Parts of Speech Comparison by Platform

Parts of Speech	Apple	Android & Both	Total
Nouns	99 words	283 words	382 words
Verbs	127 words	423 words	550 words
Adjectives	46 words	170 words	216 words
Adverbs	20 words	105 words	125 words
Prepositions	9 words	31 words	40 words
Conjunctions	1 word	5 words	6 words
Determiners	0 words	8 words	8 words
Modal Verbs	6 words	39 words	45 words
Pronouns	0 words	6 words	6 words
Totals:	1,071	308 words	1,379 words

Second, apps available through Android or both platforms ($M=194.7$, $SD=427.8$) contained new words at similar frequencies as apps available exclusively through Apple ($M=182.1$, $SD=384.9$), $t(937)=0.39$, $p=.697$. Or, put another way, apps available through Android or both platforms contained a similar distribution of new words across frequency levels as apps available exclusively through Apple, $X^2(9, N=1,366)=9.45$, $p=.397$. This means that apps available on Android or both platforms introduce children to a similar number of rare words as apps available exclusively through Apple. Table 26 shows the distribution of new words across frequency levels for apps available on Android or both platforms as well as apps available exclusively through Apple.

Table 26

New Words in Sample Storybook Apps: Frequency Comparison by Platform

Frequency	Apple	Android & Both	Total
0	27 words	98 words	125 words
1-5	60 words	189 words	249 words
6-10	17 words	56 words	73 words
11-25	20 words	63 words	83 words
26-50	11 words	63 words	74 words
51-100	19 words	54 words	73 words
101-250	28 words	65 words	93 words
251-500	2 words	20 words	22 words
501-1000	18 words	60 words	78 words
More than 1000	105 words	391 words	496 words
Total:	252 words	1,059 words	1,366 words

Finally, apps available through Android or both platforms contained a similar distribution of new words across word difficulty levels as apps available through exclusively through Apple platforms, $X^2(2, N=1,379)=1.38, p=.502$. This means apps available through Android or both platforms introduce children to a similar number of challenging words as storybook available exclusively through Apple. Table 27 shows the distribution of new words across word difficulty levels for apps available through Android and both platforms as well as apps available exclusively through Apple.

Table 27

New Words in Sample Storybook Apps: Word Difficulty Comparison by Platform

Difficulty	Apple	Android & Both	Total
2nd Grade	206 words	723 words	929 words
6th Grade	84 words	268 words	353 words
Difficult Words	18 words	80 words	98 words
Total:	308 words	1,071 words	1,379 words

In summary, apps available through Android or both platforms introduce children to similar types of new words across parts of speech, word frequency, and word difficulty as apps available exclusively through Apple. Therefore, families do not need access to Apple products – which tend to be significantly more expensive – to download storybook apps that introduce children to the full range of words they will encounter in texts throughout elementary school.

Research Question 3: Interactive Features in Preschool Storybook Apps

One key distinction between preschool storybook apps and traditional print books are the interactive features available in the app format. The goal of my third research question was to determine to what degree interactive features in preschool storybook apps are aligned to new words in the text. To do this, I adapted a coding scheme from Danielson, Wong, & Neuman (2019) who, in their study of preschool educational media, identified three theoretically informed categories of screen-based pedagogical supports: explicit definitions, visual effects, and attention-directing cues. In addition to these categories, I created a fourth category called *labeling*, which captures an interactive feature that is unique to preschool storybook apps. In this section, I share findings about the percent of new words that are highlighted by interactive features, the number of interactive features per

word, and the percentage of interactive features by type. Additionally, I share key findings about interactive features as they relate to the price of preschool storybook apps and the platforms in which they are available.

Percentage of New Words Highlighted by Interactive Features

The first part of this analysis looked at the percent of new words that are highlighted by interactive features. Overall, I identified 510 interactive features in the 70 sample storybook apps. On average, interactive features highlighted 23.3 percent of all new words in the texts. The percent of new words highlighted by interactive features ranged from 0 percent ($n=13$) to 72.7 percent (*But Not the Hippopotamus*). Thirteen apps (18.6 percent) did not highlight any new words with interactive features, whereas 30 apps (42.9 percent) highlighted 25 percent or more. This suggests that storybook apps vary widely in the number of interactive features aligned to new words in the text. Table 28 shows the ten preschool storybook apps with the highest percentage of new words highlighted by interactive features.

Table 28

Storybook Apps with the Highest Percentage of Interactive Features

Title	Developer	Platform	Price	Percentage
But Not the Hippopotamus	Loud Crow	Both	2.99	72.7
Moo, Baa, La La La!	Loud Crow	Both	2.99	66.7
Byron Barton: Planes	Oceanhouse Media	Apple	1.99	66.7
Oobie's Space Adventure	VHS Design	Apple	0	60.0
Pat the Bunny	Random House	Both	3.99	54.6
Nighty Night Construction Trucks	Author Created	Both	2.99	47.6
One Fish, Two Fish	Oceanhouse Media	Both	5.99	46.3

Table 28 (cont'd)

Title	Developer	Platform	Price	Percentage
Goodnight Moon	Loud Crow	Both	4.99	46.2
Barnyard Dance	Loud Crow	Both	2.99	44.4
Little Critter: All by Myself	Oceanhouse Media	Both	1.99	40.0

Furthermore, I analyzed the percent of interactive features that required engagement from the reader. For instance, in the storybook app *My Little Pony Best Pet*, the reader can tap on the word *strolling* and the character Rainbow Dash walks across the screen, demonstrating the meaning of the word *stroll*. In other cases, interactive features happen automatically. For example, in this same story, several animals fly across the screen above Rainbow Dash's head, illustrating what it means to pass *over* something. Almost three-quarters of interactive features (73.3 percent) require engagement with the screen. Since readers need to tap on the screen to activate the interactive feature, it is possible that this physical interaction with the text might further prompt caregivers to talk about the word with their children. However, it is also possible that caregivers might miss the interactive feature if they do not know it is present or know how to engage with the word. This is an element I explored in the second study, in which I examined how different types of interactive features influenced caregivers' word-related talk.

Types of Interactive Features

The first category, definitions, included one type of interactive feature. Unlike Danielson, Wong, and Neuman (2019), I found that the sample preschool storybook apps never provided explicit definitions of words. Instead, the interactive features in this category primarily gave examples or demonstrated the meaning of new words. I found the sample preschool storybook apps used definitions with 23.7 percent of all new words in the text. For example, in *The Kissing Hand*, the reader can hear a school bell ringing on the screen, demonstrating the meaning of the word *rang*. In

Byron Barton: Trains, three train cars drive across the screen, each carrying a different type of *freight*: lumber, coal, and brick, providing readers with examples of the new word. Approximately 90 percent of words in this category demonstrated the meaning of new words, whereas the other 10 percent provided readers with examples.

The second category, visual supports, included visual effects to scaffold a deeper understanding of vocabulary words. The sample preschool storybook aps used visual supports with 37.9 percent of new words. For instance, in the storybook app *The Tale of Squirrel Nutkin*, the reader can move Nutkin in a boat across the pond, and the character shows what it looks like to *paddle* across the water. In *Windy's Lost Kite*, wind visibly blows the characters' hats, scarfs, and jackets, showing readers what a *blustery* day looks like.

The third category, *labeling*, was the most-used interactive feature in the sample apps. Labeling was used with 45.6 percent of new words. This category included two different types of supports that identified words for readers: tapping a picture, in which a narrator named the item, and tapping on a word in the text, in which the narrator read it out loud. For example, in the storybook app *Care for our World*, the reader can tap on a picture of a small fish and the narrator says the word *guppies*. In *My Little Pony: Party of One*, the reader can tap on the word *disguise* in the sentence and the narrator reads the word out loud. Labeling a picture occurred with 86 percent of all new words in this category, whereas labeling a word in a sentence occurred with the other 14 percent.

The final category, viewer attention and interaction, included three types of interactive features that engaged readers in word learning experiences on the screen: attention-directing cues (Silverman & Hines, 2009), sound effects (Verhallen et al., 2006), and an invitation to participate or interact with the vocabulary word (Restrepo et al., 2013). The sample preschool storybook apps used viewer attention and interaction with 22.7 percent of all new words. For instance, the storybook app *Nighty, Night Construction Trucks* used a dripping sound (sound effects) to draw readers' attention to

water dripping from a pipe. In *My Little Pony: Cutie Pox*, a large, glowing star appears in front of Apple Jack's tooth (attention-directing cues), drawing readers' attention to the characters' tooth growing inside her mouth. The app, *Pat the Bunny*, invites readers to engage with the word "inside," by repeatedly asking the question, "can you find out what's inside?" Sound effects were the most common type of attention-directing cues at 66.3 percent, followed by attention-directing cues at 25.8 percent, and invitations to engage with new words at 13.2 percent. Supports in this category were always coded in conjunction with another category because attention-directing cues may effectively draw readers' attention toward specific words but do not necessarily teach the meanings of those words.

Number of Interactive Features per Word

Given this study's theoretical framing of dual coding theory, I sought to understand the relationship between the number of interactive features per word. For instance, the category *labeling* is a verbal message, where the narrator is reading a new word out loud for the listener or identifying the name of a picture. There is an image on the screen, but the interactive feature itself is a verbal one. By contrast, the categories *definitions* and *viewer attention and interaction* include a combination of verbal and nonverbal cues. I analyzed the categories in relation to one another to see if patterns or trends emerged among verbal and nonverbal codes.

Nearly three-fourths (74.3 percent) of new words were highlighted by just one interactive feature. For example, in the storybook app *Tacky Goes to Camp*, the reader can tap on a picture of graham cracker crumbs, and the word *crumbs* appears above the picture (labeling). More than twenty percent of new words (21.6 percent) were highlighted by two interactive features. For instance, in the storybook app *Goodnight, Goodnight, Construction Site*, the reader can tap on a picture of a bulldozer and the character demonstrates the meaning of the word *snores* by closing its eyes and opening and closing its mouth (visual support) as well as making an audible snoring noise (definitions). Finally,

four percent of new words (4.1 percent) were highlighted by three interactive features. In *My Little Pony: Cutie Pox,* the word *exciting* is highlighted in purple font (viewer attention). The reader can then tap on the word and the narrator reads it out loud (labeling) while the character Apple Jack jumps up and down (visual support), demonstrating the meaning of the word.

In sum, preschool storybook apps typically use one or two interactive features to highlight new words in the text. The most common type of interactive feature is labeling, which is used 47.6 percent of the time. This is followed by visual supports at 38.4 percent and definitions at 14 percent. The most frequent combination of interactive features is viewer attention and interaction alongside visual supports. This combination accounted for 58.8 percent of all interactive features used in tandem with new words, followed by viewer attention and interaction paired with definitions (31.8 percent) and viewer attention and interaction paired with labeling (5.9 percent). It is not evident that interactive features were paired with one another in an intentional way to impact the readers' experience.

Price: Impact on the Percent of New Words Highlighted by Interactive Features

Interactive features draw attention to and provide readers with more information about new words. As such, it is important to explore how the price of the app might impact the percentage of new words that are highlighted by interactive features. Notably, free and $0.99 apps ($M$=0.20, SD=0.16) contain a similar percentage of new words highlighted by interactive features as apps priced higher than $1.00 ($M$=0.24, SD=0.20), t(68)=-0.87, p=.386. This finding is also the same for storybook apps priced below $3.00: apps priced at $2.99 and below ($M$=0.23, SD=0.20) contained a similar percentage of new words highlighted by interactive features as apps priced higher than $3.00 ($M$=0.25, SD=0.16), t(68)=-0.35, p=.726. Taken together, free and low-cost storybook apps give children access to similar amounts of new words highlighted by interactive features as apps at higher price points.

Platform: Impact on the Percent of New Words Highlighted by Interactive Features

Like the price, it is also important to consider how the platform (i.e., Apple or Android) might impact the percentage of new words highlighted by interactive features. Apps available through Android or both platforms (M=0.22, SD=0.18) contained a similar percentage of new words highlighted by interactive features as apps available exclusively through Apple (M=0.28, SD=0.21), $t(68)$=-1.31, p=.195. As such, families do not need to have access to Apple products – which tend to be significantly more expensive – to access storybook apps with a similar number of new words highlighted by interactive features.

Summary of Findings

In summary, the preschool storybook apps in my sample are ripe with opportunities to learn new words: 7.56 percent of all words in preschool storybook apps might be considered new for children of this age. Furthermore, every storybook app in my sample contained at least one new word, with nearly 83 percent of apps containing five or more. In addition, preschool storybook apps also introduce children to a range of different word types across parts of speech, frequency, and word difficulty. This includes some of the most challenging word types – prepositions, determiners, conjunctions, and pronouns – as well as words that are rarely used in everyday conversations with children. Perhaps the most remarkable finding is that nearly two-thirds of the new words in the sample apps occurred 50 or less times in the Parental Frequency Corpus (Han et al., 2005; MacWhinney, 2000; Wellman & Woolley, 1990), with 13 percent of those words not occurring at all. Given that many of the words from preschool storybook apps are unlikely to occur often in conversations with children, it is particularly important that we introduce these words through read alouds of texts that contain them.

Furthermore, interactive features highlight nearly one-fourth of all new words in preschool storybook apps. The most common type of interactive feature is *labeling,* which was used with nearly

46 percent of new words. Storybook apps also contain interactive features that demonstrate the meaning of new words, give examples, and provide visual support to help readers understand new words in the text. Additionally, storybook apps engage readers in word learning experiences in three different ways: by attention-directing cues (Silverman & Hines, 2009), sound effects (Verhallen et al., 2006), and an invitation to participate or interact with the vocabulary word (Restrepo et al., 2013). In the next chapter, I explore how these interactive features influence caregivers' word-related talk while reading storybook apps out loud with their preschool-aged children.

Finally, these findings have exciting implications for equity as it relates to children's access to texts. Families with limited resources can gain access to children's stories that have a high percentage of new words through free and low-cost storybook apps that are available on the lowest-priced tablets on the market. These free and low-cost storybook apps also introduce children to similar types of words across parts of speech, frequency, and word difficulty, and offer readers a similar percentage of new words highlighted by interactive features. However, it is important to keep in mind that while these free and low-cost apps might contain similar proportions and types of new words, these apps are typically shorter in length than those at higher price points, which leads to less new words overall. Therefore, families who rely solely on free and low-cost storybook apps would need to read more stories overall to equal the same number of new words as children who can access more expensive apps.

CHAPTER 5 – STUDY 2 FINDINGS: RESEARCH QUESTION 4

The primary goal of this study was to describe the relationship between interactive features and caregivers' word-related talk while reading preschool storybook apps out loud with their children. During this study, 37 caregivers of four- and five-year-old children read four stories each for a total of 68,635 words in 148 sessions, totaling over 2,220 minutes of read aloud time. The following research question guided this study: How might interactive features closely aligned to the words in storybook apps influence caregivers' word-related talk? In this chapter, I first introduce the four preschool stories I used for this study and explain my rationale for their use. Then, I describe the six different ways caregivers talked about words with their children while reading aloud in both mediums. Next, I present findings about the influence of interactive features on caregivers' word-related talk. Finally, I discuss the relationship between interactive features and the amount and types of word-related talk they elicit from caregivers.

The Preschool Storybook Apps

In this section, I describe the four preschool storybook apps I used in this study: *Kalley's Machine Plus Cats*; *Even Monsters Get Sick*; *How I Became a Pirate*; and *My Little Pony Best Pet*. First, I present an overview of the storybook selection procedures. Then I describe each of the four stories in detail, sharing information about the plot, number and types of new words in the story, and the number and types of interactive features that highlighted these new words. Additionally, I share information about the number of times caregivers read the story in each format (i.e., print or digital). Given the uneven number of participants in the study, two stories were read 18 times in storybook apps format, while the other two stories were read 19 times. This same information is also presented in Chapter 3 (Table 10). Finally, I provide a rationale for why I selected these four stories among the 70 apps in the sample to use for the read aloud sessions.

Table 29

Description of Storybook Apps Selected for Read Aloud Sessions

Title	Developer	Percent New Words	Percent Interactive Features	Lexile Range
How I Became a Pirate	Oceanhouse Media	9.0	21.5	410-600L
Even Monsters Get Sick	Busy Bee	6.6	20.0	410-600L
My Little Pony: Best Pet	Playdate	11.6	28.6	410-600L
Kalley's Machine Plus Cats	Rocket Wagon	12.1	21.2	410-600L

Overview of Storybook Apps in the Read Aloud Sessions

Table 29 provides an overview of the four stories selected for this study. The storybook apps included narrative stories available through both platforms: Apple and Android, as families were invited to use a tablet of their choice to participate in the study. The initial storybook selection criteria were as follows: (a) contains colorful illustrations that help narrate the story; (b) contains vocabulary words in the text that are unlikely to be known by preschool-aged children; (c) are neither excessively long nor heavily reliant on text for telling the story; and (d) are developmentally appropriate (i.e., designed for children ages 3-5). Using these criteria as a guide, I first used Lexile text measures to select a set of texts written at equal readability levels. I chose 410L-610L as my starting point, because most of the storybook apps in my sample (52.9 percent) were written at this level. From there, I selected four stories with a similar percentage of new words in the text. I also looked for a similar percentage of these new words to be highlighted by interactive features in the text. Table 30 lists the new words in each story and notes which of these new words were highlighted by interactive features.

Table 30

Description of New Words in Storybook Apps Selected for Read Aloud Sessions

Title	New Words	New Words Highlighted by Interactive Features
Kalley's Machine Plus Cats	machine, like, wonder, clue, points, levers, dials, controls, must, bash, casually, figure, scolds, puff, too, still, whole, want, reply, nonchalant, confused, stamps, shapes, makes	levers, dials, controls, bash, stamps, shapes, makes
Even Monsters Get Sick	socks, disguise, until, gurgled, dripped, goo, still, make, looked, temperature, soup, favorite, happened, twinkle, toes, helped, taught, spookiest, hide, wanted, would, world	gurgled, soup, twinkle, toes, spookiest
How I Became a Pirate	teeth, crossbones, tried, busy, landed, head, must, moat, chest, find, bury, shouted, would, announced, teach, real, pounded, gulped, spinach, whispered, matter, gulp, past, unless, want, bellowed, only, looked, confused, finally, hide, hammock, cabin, hatches, mast, help, over, find, added	teeth (2), head (2), chest (2), shouted (4), hatches, mast, gulped, bellowed
My Little Pony Best Pet	strolling, wanted, own, participating, help, find, excited, like, impressed, announced, would, wondered, already, introduced, compete, guts, style, coolness, unique, competition, final, test, challenged, rules, obstacles, prickly, tangled, thorns, lead, suddenly, worried, over, realized, most, declared, rest, disappointed, courageous, congratulated, made, outfit	strolling, excited, announced, challenged, realized, congratulated, participating, impressed, introduced, declared wondered, unique, announced, worried, own, over

Kalley's Machine Plus Cats

Kalley's Machine Plus Cats, created by Rocket Wagon, is an interactive storybook app inspired by Kalley, the four-year-old daughter of the app developer, who drew a picture of a special machine that could help her family. Throughout the study, this story was read 18 times as a print book and 19 times as a storybook app. *Kalley's Machines Plus Cats* is the shortest of the four stories at 14 pages long (273 words) and centers around two main characters: Kalley and her father. Throughout the story, readers can interact with the machine that Kalley built for her dad, who is unaware of how the machine works or the purpose behind it. After turning cranks, pointing out levers and dials, and showing him a boiler with fire inside, Kalley reveals that the machine makes food for their family, so her dad no longer needs to go to work to earn money for groceries. The story also features the family's cat on each page, who interacts with the machine in playful ways on every screen.

Kalley's Machine Plus Cats costs $0.99 through the Amazon App Store and the Apple App Store and is based on original content (i.e., there is not a corresponding print book). The story features 24 unique new words (33 new words total) including words such as *wonder*, *scolds*, *confused*, and *nonchalant*. The new words are primarily verbs (41.7 percent) and nouns (25 percent) but also include adjectives (whole; confused), adverbs (casually; still; too), prepositions (like), and modal verbs (must). The words range in frequency from zero (one word: nonchalant) to 941 (must), with an average frequency of 176 (*SD*=319.3) and contains words in all three categories of difficulty: words to teach before second grade (70.8 percent); words to teach before sixth grade (12.5 percent); and difficult words (16.2 percent). The four words in the difficult category are *dials*, *casually*, *still*, and *nonchalant*.

Included in the app are seven interactive features aligned to these new words in the story. All the interactive features have a one-to-one correspondence to the new words (i.e., none of the new words are highlighted by more than one interactive feature). Four of these interactive features are

definitions: three demonstrate how *levers*, *dials*, and *controls* work, while one provides an example of the word *shapes*. The other three interactive features provide readers with visuals of *bash*, *stamps*, and *make*. Seventy-one percent of the interactive features in the app require readers to engage with the screen, while the other 29 percent happen automatically.

Even Monsters Get Sick

Even Monsters Get Sick, created by Busy Bee Studios, is an interactive storybook app about Harry, who has just traded three stickers, two sticks of gum, and one skateboard for a pet monster named Zub. Throughout the study, this story was read 18 times as a print book and 19 times as a storybook app. *Even Monsters Get Sick* is 22 pages long (380 words) and follows Harry as he tries to figure out what is wrong with his new pet monster, who despite trips to the movies, hopping on a double-pop space hop, and a triple-scoop, banana-whip, peppermint ice cream sandwich still just sits there, looking bored. After Zub sneezes, Harry realizes his new pet is not actually bored, but sick, and he begins a quest to nurse his new monster back to health.

Even Monsters Get Sick costs $0.99 through the Amazon App Store and the Apple App Store and is based on original content. The story contains 21 unique new words (25 new words total) including such words as *disguise, gurgled, dripped,* and *spookiest*. The new words are primarily verbs (47.6 percent) and nouns (28.6 percent) but like *Kalley's Machine Plus Cats*, also includes adjectives (favorite; spookiest), adverbs (still), prepositions (until), and a modal verb (would). The words range in frequency from zero (two words: gurgled and spookiest) to 838 (until), with an average frequency of 167.4 (*SD*=391.2) and contains words in all three categories of difficulty: words to teach before second grade (90.5 percent); words to teach before sixth grade (4.8 percent); and difficult words (4.8 percent). There is one word in the difficult category, *still*, and seven words with a frequency less than 50: *gurgled* (0), *spookiest* (0), *dripped* (1), *disguise* (4), *goo* (9), *twinkle* (25), and *temperature* (47).

There are seven interactive features in *Even Monsters Get Sick*. Two words are highlighted by multiple interactive features: *twinkle* (viewer attention and interaction; visual support) and *toes* (viewer attention and interaction; visual support). The remaining three new words have one interactive feature each: *gurgled* (definitions: demonstrating the meaning); *soup* (visual support); and *spookiest* (visual support). Forty percent of the interactive features in this app require readers to engage with the word, whereas the other 60 percent happen automatically.

How I Became a Pirate

How I Became a Pirate, created by Oceanhouse Media, is an interactive storybook app about Jeremy Jacobs, who is invited by Braid Beard and his crew to join them on their pirate ship and help bury some hidden treasure. Throughout the study, this story was read 19 times as a print book and 18 times as a storybook app. *How I Became a Pirate* is the longest of the four stories at 45 pages (720 words) and takes readers along with Jeremy Jacobs as he learns to sing sea chanteys, say real pirate words like "landlubber" and "scurvy dog," and revels in the fact that no one makes pirates finish their dinner, go to bed, or brush their teeth. However, after a string of bad events – no bedtime story, no one to tuck him in, and a thunderstorm at sea – Jeremy Jacob decides being a pirate is not that great after all.

How I Became a Pirate costs $3.99 through Google Play, the Amazon App Store, and the Apple App Store and is the only story of the four based off a print book of the same title – published in 2003 by Melinda Long and David Shannon. The story contains 39 unique new words (65 new words total) and, in addition to "pirate words" (largely excluded from the analysis), includes such words as *moat, announced, gulped,* and *whispered*. Like the previous two stories, the new words are primarily verbs (43.6 percent) and nouns (25.6 percent) but also includes a mix of adjectives (busy; real; fine), adverbs (finally; over), prepositions (past), conjunctions (unless), and modal verbs (would; must). The words range in frequency from zero (four words: crossbones, moat, bellowed, and mast)

to 941 (must), with an average frequency of 118.5 (*SD*=374.7), and contains words in all three categories of difficulty: words to teach before second grade (79.5 percent); words to teach before sixth grade (15.4 percent); and "difficult" words (5.1 percent). The two words in the difficult category are *crossbones* and *mast*.

There are 14 total interactive features in *How I Became a Pirate*. All the interactive features in this story have a one-to-one correspondence to the new words. Eight interactive features (57.1 percent) label pictures of new words in the story: *head* (as in "head pirate") (two times), *teeth* (two times), *chest* (as in "chest of gold") (two times), *hatches*, and *mast*. The other six interactive features (42.9 percent) provide definitions: four demonstrate the meaning of the word *shouted*, one demonstrates the meaning of the word *gulped*, and one demonstrates the meaning of the word *bellowed*. Seventy-one percent of the interactive features require readers to engage with the word, whereas the other 29 percent happen automatically.

My Little Pony Best Pet

My Little Pony Best Pet, developed by Playdate*,* is an interactive storybook app about Rainbow Dash, who is in search of her own pet so she can join the weekly pet playdate in the park with her friends. Throughout the study, this story was read 19 times as a print book and 18 times as a storybook app. *My Little Pony Best Pet* is 38 pages long (482 words) and follows Rainbow Dash, who organizes a race between her pet candidates to choose the winner. The most unlikely candidate – a slow-moving tortoise – becomes Rainbow Dash's new pet when he is the only one to stop to help her after she becomes trapped under a rock as they race through Ghastly Gorge.

My Little Pony Best Pet costs $2.99 through the Amazon App Store and the Apple App Store and is based on original content. The story contains 41 unique new words (56 new words total) and includes words such as *participating, impressed, introduced,* and *unique*. The new words are primarily verbs (36.6 percent), nouns (26.8 percent), and adjectives (22 percent) but also includes adverbs (already;

suddenly), prepositions (like; over), determiners (most), and modal verbs (would). The words range in frequency from zero (three words: obstacles, declared, and courageous) to 707 (wanted), with an average frequency of 125 (*SD*=349.9), and contains words in all three categories of difficulty: words to teach before second grade (68.3 percent); words to teach before sixth grade (24.4 percent); and "difficult" words (7.3 percent). *My Little Pony Best Pet* also contains 26 new words with a frequency less than 50. Some examples of these words include *strolling* (1), *announced* (3), *compete* (3), *challenged* (5), and *impressed* (10).

There are 32 interactive features in *My Little Pony Best Pet* – the most of any storybook app of the four. Six new words have three interactive features each: *strolling, excited, announced, challenged, realized*, and *congratulated*. All six of these words are highlighted in purple font in the text (viewer attention). When the reader taps on one of these purple words, the narrator reads the words out loud (labeling) and one of the characters demonstrates the meaning of the word (definitions). Four new words have two interactive features: *participating, impressed, introduced*, and *declared*. These four words were also highlighted in purple font in the text (viewer attention). When the reader taps on one of these words, the narrator reads the word out loud (labeling), but none of the characters demonstrate the meaning. The remaining six words have just one interactive feature: *wondered* (demonstrating the meaning); *unique* (visual support); *announced* (demonstrating); *worried* (demonstrating), *own* (visual support), and *over* (demonstrating). Ninety-three percent of the interactive features in this app require the reader to engage with the word, whereas the other seven percent happen automatically.

Rationale for Storybook App Selection

In addition to being written at the same Lexile level and having a similar percentage of new words and interactive features, I selected these four storybook apps for several reasons. First, these storybook apps contain similar types of new words: primarily nouns and verbs, at similar frequency

levels, and with a comparable distribution across word difficulty categories. This is important, as my research question focused on the influence of interactive features – not types of words – and as such, I wanted each storybook app to be as similar as possible when it came to the words in the text. This way, I could minimize the impact of the word-level variables on caregivers' talk to the greatest extent possible.

Second, I chose these four storybook apps because they represent the range of interactive features present in the sample storybook apps in the first study. The *My Little Pony* storybook apps (of which there are three total apps in the sample) are the only stories that highlight new words with three interactive features – viewer attention and interaction, labeling, and definitions – and are also the only apps in the sample that highlight vocabulary words using different colored font. Similarly, *How I Became a Pirate* is the only storybook app of the four that labels pictures for readers. By choosing storybook apps that represent the full range of interactive features available, as well as different amounts of interactive features per word (i.e., one, two, or three), I am able to test the influence of both the type and number of interactive features on caregivers' word-related talk.

Finally, I chose these four storybook apps due to their length: two of these stories are relatively short (*Kalley's Machine Plus Cats* and *Even Monsters Get Sick*) and two of these stories are relatively long (*How I Became a Pirate* and *My Little Pony Best Pet*). When I assigned the story conditions ahead of the read aloud sessions, I ensured that each session included one short story and one long story. This kept the two read aloud sessions roughly equal in length and prevented read aloud sessions in which the two long stories were read back-to-back in one sitting. It was my hope that this would reduce the caregivers' reading fatigue as well as keep the children interested through both stories.

Types of Caregivers' Word-Related Talk

In this section, I share findings based on the different strategies caregivers used to talk about new words with their children during the read aloud sessions. Throughout the study, caregivers talked about words 101 times and relied on six different strategies to do so: providing a definition, giving an example, pointing to a picture, asking questions, expanding utterances, and making connections. Table 31 describes the six different ways that caregivers engaged in word talk with their children during the read aloud sessions.

Table 31

Types of Caregivers' Word-Related Talk

Label	Definition	Examples
Definition of Word	The caregiver explains the meaning of the word to the child.	"Twinkle means something is sparkling."
Providing an Example	The caregiver gives the child an example of the word.	"Do you remember when we saw that person throw some trash out their car window? That's littering."
Pointing to a Picture	The caregiver points to a picture that illustrates the word in the text.	"Do you see this big puddle of green stuff under the monster? This is goo."
Asking Questions	The caregiver asks the child a question about the word.	"Humongous! What a cool word. Do you know what that means?"
Expanding Utterances	The caregiver adds more information to what the child says.	"Yes, humongous means something is really, REALLY big!"
Making Connections	The caregiver connects the word to something the child already knows.	"Do you remember when we saw all the holiday lights blinking on the light posts downtown? Those were 'twinkling' lights."

In most of these instances (80.7 percent), caregivers used just one strategy to talk about new words with their children. For instance, after reading a new word in the text, the caregiver might point at a picture of the word in the story to help them explain the meaning to their child. However, caregivers occasionally used more than one strategy to do so. For example, the caregiver might first ask their child, "do you know what this word means?" and then explain the meaning of the word if they answer "no." Like this example, caregivers used two different strategies with the same word 15.7 percent of the time, and three strategies 3.6 percent of the time.

Defining New Words

Caregivers provided their children with definitions of new words 17 times, which comprised 16.8 percent of all the word-related talk in the study. In these instances, caregivers explained the meaning of the word to their child using their own definitions. For instance, in the example below, the caregiver explains the meaning of the word *excited* in the storybook app, *My Little Pony Best Pet*. In addition to providing a definition, the caregiver begins by asking their child if they know the meaning of the word:

> **Caregiver** (reading the text): Fluttershy was so *excited* to show Rainbow Dash all the pets to choose from at her cottage. [New word in italics]
>
> **Caregiver:** So, click on the purple word. That's excited. It starts with an "e." Excited. [Word is highlighted in purple in the text]
>
> *Child clicks on the word 'excited' in the app; the narrator reads the word out loud*
>
> **Caregiver:** What does excited mean?
>
> **Child:** Uh…loud?
>
> **Caregiver:** It's kinda like when you hop up and down. You're really excited right? You're very energetic and kinda enthusiastic about whatever you're going to be doing.

In another example, a different caregiver explains the meaning of the word *impressed* in the same storybook app, *My Little Pony Best Pet*. In this instance, the caregiver provides a definition of the word without engaging in a second type of word-related talk:

> **Caregiver** (reading the text): Rainbow Dash was so *impressed* by all the animals. [New word in italics]
>
> *Caregiver taps on the word 'impressed' in the app; the narrator reads the word out loud*
>
> **Caregiver:** Impressed. So, there are too many good animals. She cannot choose.

In both examples, the caregivers provide their children with definitions of the words in the story. Throughout the study, there were no instances of caregivers stopping to look up the meaning of the word for their child; the caregivers simply crafted a definition in their mind during the read aloud session and shared that definition with their child, before continuing with the rest of the story.

Providing Examples

Caregivers provided their children with an example of a new word 18 times, which comprised 17.8 percent of all the word-related talk in the study. In these instances, caregivers gave their children examples of the new word instead of providing them with the definition. In the example below, the caregiver gives an example of the word *impressed* from the story, *My Little Pony Best Pet.*

> **Caregiver** (reading the text): Rainbow Dash was so *impressed* by all the animals. [New word in italics]
>
> **Caregiver:** So, impressed is like when someone does a backflip and you're like, whoa! That's being impressed.

In another example, a different caregiver provides multiple examples for the word *shapes* in the story, *Kalley's Machine Plus Cats*. In this instance, the caregiver uses two strategies to talk about the

word: giving an example and pointing to a picture. In this case, the picture is a machine that has buttons with different items on them that children can press in the storybook app.

> **Caregiver** (reading the text): She says it stamps *shapes* of the things that you choosed. [New word in italics].
>
> **Caregiver**: Hmmm…so here's a bunny [points to picture] and cars [points to picture] and bears [points to picture] and sandcastles [points to picture]. Those are the shapes. Like circles, triangles, squares [provides examples].

In both cases, the caregivers provided their children with examples of the words to help explain their meaning. Like definitions, there were no instances of caregivers stopping to find examples from other sources (e.g., closing the app and searching for a picture on the internet); the caregivers simply thought of a few examples that came to mind, shared them with their children, and then continued reading the story.

Pointing to Pictures

Caregivers pointed to pictures in the story 51 times – more than any other strategy – which encompassed 50.5 percent of all word-related talk that occurred in the study. In these instances, caregivers pointed at a picture of the new word in the text to help explain the meaning to their child. For instance, in the example below, the caregiver points to a picture of a ghost in the story, *Even Monsters Get Sick*, to show their child what the word *spookiest* looks like.

> **Caregiver** (reading the text): He told the *spookiest* stories at Kid Camp. [New word in italics]
>
> **Caregiver:** Wow, look at that.
>
> *Caregiver points to the picture of the ghost.*
>
> **Caregiver:** Those look like some spooky stories.

In another example, a different caregiver points to a picture of a hatch in the story, *How I Became a Pirate*, to show their child what a hatch on a ship looks like. The caregiver further mentions that hatches should be closed during a storm (which is occurring in the story), giving the child a clue about its purpose.

Caregiver: (reading the text): Batten down the *hatches!* [New word in italics]

Caregiver: That's a hatch right there [points to picture]. They should close those up, right?

In both examples, caregivers relied on the pictures in the text to help explain the meaning of the new word to their child. Notably, caregivers never relied on another source – such as looking up a picture of the word on the computer – to show their children a new word. Caregivers solely relied on the pictures in the text to do so.

Asking Questions

Caregivers asked questions to draw their children's attention to new words 10 times, which comprised 9.9 percent of all the word-related talk in the study. In these instances, caregivers primarily asked their child whether they knew the meaning of a particular word. However, there were several instances that caregivers used questions to check whether their child understood the word in the context of the story. Asking questions was the strategy caregivers were most likely to use in tandem with another type of word-related talk. In the example below, the caregiver uses questions in the story, *Kalley's Machine Plus Cats*, to check whether their child knows the difference between *levers* and *dials*.

Caregiver (reading the text): Next, she points to some *levers* and *dials*. [New words in italics]

Caregiver: Where are the levers?

Child points to a picture of the lever on the screen.

Caregiver: Where are the dials?

Child points to a picture of the dials on the screen.

Caregiver: Maybe. Good.

In another example, a different caregiver asks their child if they know the meaning of the word *challenged*. After the child shakes their head no, the caregiver follows up by explaining the meaning of the word.

> **Caregiver** (reading the text): To choose the winner, Rainbow Dash *challenged* all the animals to a race through Ghastly Gorge. [New word in italics]
>
> **Caregiver:** Challenged. Do you know what challenge means?
>
> *Child shakes head no.*
>
> **Caregiver:** It's basically what Rainbow Dash is doing. She's saying, let's do this thing. I want all of you to do this thing.

In both examples, caregivers asked their child questions about a new word in the text. In the first example, the caregiver used a question to check whether their child understood the meaning of the words *levers* and *dials*. In the second example, the caregiver used questions to check whether they needed to explain the meaning of the word before continuing with the story.

Expanding Utterances

Caregivers expanded their child's utterances about a new word three times, which comprised just three percent of all word-related talk in the study. In these instances, caregivers used their child's comments about a new word as a starting point to say more about it. In the example below, the caregiver expands on the child's comment about a picture in the story, *Even Monsters Get Sick*, to say more about the word *spookiest*.

> **Caregiver** (reading the text): He told the *spookiest* stories at Kid Camp. [New word in italics]
>
> **Child:** His friends are getting scared.
>
> **Caregiver:** Yes, because it's a spooky, scary story.

In another example, a different caregiver takes advantage of their child playfully pointing at pictures of *levers* in the story, *Kalley's Machines Plus Cats*. Here, the caregiver offers a definition of the word and then points a picture of another new word, *dials,* nearby.

> **Caregiver** (reading the text): Next, she points to some *levers* and *dials*. [New words in italics]
>
> **Child:** That's a lever [points to picture] and that's a lever [points to picture] and that's a lever [points to picture].
>
> **Caregiver:** Uh-huh. That's a lever. It moves that thing up and down. And that's a dial [points to picture].

In both examples, caregivers expanded their child's comments to say more about a new word in the text. In the first example, the caregiver expanded their child's comment about the characters looking scared to make a connection to the word *spookiest* in the story. In the second example, the caregiver expanded their child's comments about the *lever* to explain the meaning of the word, as well as point out a picture of another new word in the text, *controls*.

Making Connections

Finally, caregivers made connections between new words in the text and other experiences in their children's lives two times, which comprised only two percent of all word-related talk in the study. In these instances, the caregivers explained the meaning of a new word by relating it to something the child already knew. For instance, in the example below, the caregiver explains the word *participating* in the story, *My Little Pony Best Pet*. After explaining the meaning of the word, the caregiver makes a connection between *participating* and playdates. The caregiver also makes a connection to what it feels like when they are excluded from events.

> **Caregiver** (reading the text): Rainbow Dash said she understood but was secretly a little upset that she wasn't *participating*. [New word in italics]

Caregiver: So, participate means to join. Like when you participate in something, you join

something. So, you participate in a party, you participate in a playdate, right? So, you

join. And when we're asked not to participate, that's a little sad.

In another example, a different caregiver makes a connection between the word *temperature* in

the story, *Even Monsters Get Sick*, and a forehead thermometer, which has risen in popularity during

the COVID-19 pandemic. Here, the caregiver acts out using a forehead thermometer on their child

to take their temperature.

Caregiver (reading the text): Then he checked his *temperature*. [New word in italics]
Caregiver uses their hand and pretends to use a forehead thermometer.
Caregiver: It's like when we have to stop at the bottom of the stairs before school. Beep,

beep, beep. See? I just checked your temperature; you can go inside.

In both examples, the caregivers make connections between new words in the text and

children's experiences in real life. In the first example, the caregiver makes a connection between the

word *participating* and playdates to help the child further understand the meaning of the word they

have just explained. In the second example, the caregiver makes a connection between the word

temperature and a forehand scanner, acting out a scene at school where children are required to have

their temperatures taken before entering the building.

Influence of Interactive Features on Caregivers' Word-Related Talk

In this section, I share findings for Research Question 4: How might interactive features

closely aligned to the words in storybook apps influence caregivers' word-related talk? Throughout

the study, caregivers read a total of 6,623 new words in both app and print format – or 179 new

words each. They talked about a total of 83 new words, or 1.25 percent of all the new words in the

texts. This included new words in both print book and storybook app format, as well as words

highlighted by interactive features and those that were not.

Of these 6,623 new words, caregivers read 786 new words that were highlighted by interactive features. By nature, all these words were in storybook app format (i.e., print books do not contain digital interactive features). Of these 786 new words, caregivers talked about 36 of them, or 4.58 percent of all new words that were highlighted by interactive features in storybook apps.

Additionally, caregivers also read 5,789 new words that were not highlighted by interactive features. These new words were in both formats: print books and storybook apps, as not every new word in storybook apps were highlighted by interactive features (i.e., these words appeared similar to the words found in print books). Of these new words, caregivers talked about 47 of them, or 0.81 percent of all new words not highlighted by interactive features.

Furthermore, caregivers also talked about 70 words that were not considered "new words" for preschool-aged children. These were words such as *bored, tank, tapping,* and *storm* that appeared in the "easy" category on the Words Worth Teaching List (Biemiller, 2009). This also included words such as *swabbing, sunblock, twitch,* and *slather* that were excluded from analysis because they did not appear in any category, and words such as *yonder* that were excluded because they are considered slang words or phrases. Of these 70 words, 61.4 percent – or 43 words – were highlighted by interactive features.

Taken together, caregivers talked about significantly more new words when they were highlighted by interactive features than words that were not, $X^2(1, N=6,623)=79.60, p<.001$. In other words, although caregivers talked about relatively few words overall, those that they did talk about with their children were more likely to be accompanied by interactive features in storybook app format. This suggests that interactive features might have influenced the new words that caregivers chose to talk about with their children during the read-aloud sessions.

Word-Level Features and Caregivers' Talk

Although the storybook apps in the sample were similar in terms of the types of new words in the text, the words themselves varied within the stories. For instance, over 46 percent of the new words in *My Little Pony Best Pet* had a frequency less than 50, yet the text also included words at much higher frequencies such as *already* (640) and *wanted* (707). Words with lower frequencies mean they are used less often in everyday conversation, which makes it more likely that children might have never encountered these words before hearing them read out loud. However, I found that the new words that caregivers talked about during the read aloud sessions (M=109.1, SD=320.5) did not have significantly different frequencies than the new words that caregivers did not talk about (M=248.7, SD=453.1), t(74)=1.40, p=.166. This means that caregivers were just as likely to talk about more common words – such as *already* and *wanted* – as they were to talk about words that are used less frequently, such as *obstacles, declared*, and *courageous*. This finding suggests that frequency did not influence which words caregivers talked about during the read aloud sessions.

Additionally, while most of the new words in the storybook apps were nouns and verbs, the stories also contained more challenging word types, such as adjectives, adverbs, conjunctions, and prepositions. However, the new words that caregivers talked about did not have a significantly different distribution across parts of speech than new words that caregivers did not talk about, X^2(7, N=125)=6.52, p=.089. This means that caregivers were just as likely to talk about new words that were concrete nouns, such as *dials* and *controls*, as they were to talk about more challenging word types, such as adjectives (e.g., *unique)* and adverbs (e.g., *gently)*. This suggests that parts of speech also did not influence which words caregivers talked about during the read aloud sessions.

Finally, while most of the new words in the storybook apps fell into the second category of the Words Worth Teaching List (Biemiller, 2009) (i.e., words to teach before second grade) each storybook app contained words in all three categories, including the most "difficult" words on the

105

list. However, the new words that caregivers talked about did not have a significantly different distribution across difficulty levels as new words that caregivers did not talk about, $X^2(2, N=125)=2.23, p=.329$. This means that caregivers were just as likely to talk about words such as *toes*, *soup*, and *help* as they were to talk about "difficult" words such as *nonchalant* and *casually*. Again, this finding suggests that word difficulty did not influence which words caregivers talked about during the read aloud sessions.

Taken together, these findings are important because it suggests that the word-level features did not influence which words caregivers chose to talk about during the read aloud sessions. While it is possible that another factor, including a different word-level feature not explored in this study, might have influenced caregivers' decisions to talk about a word, these results further suggest that interactive features influenced the words caregivers chose to talk about with their children. Appendix D shows the words from all four storybook apps that caregivers talked about during the read-aloud sessions.

Relationship between Interactive Features and Caregivers' Word-Related Talk

In the final section, I explore the relationship between the amount and types of interactive features and caregivers' word-related talk. There were 60 total interactive features aligned to new words in the four preschool storybook apps. As mentioned earlier, caregivers read these words 786 times and talked about them 36 times – or 4.58 percent of all new words highlighted by interactive features. To explore the relationship between the interactive features and caregivers' word-related talk, I asked the following questions:

1. How does the number of interactive features per word influence caregivers' word-related talk?

2. How does engaging with interactive features in the text (i.e., tapping on the screen) impact caregivers' word-related talk?

3. How do the types of interactive features influence caregivers' word-related talk?

4. How do the types of interactive features influence the strategies caregivers use to talk about new words?

Number of Interactive Features

The first question asked whether the number of interactive features per word influenced caregivers' word-related talk during the read-aloud sessions. In the first study, I found that new words were highlighted by one interactive feature 74.3 percent of the time; two interactive features 21.6 percent of the time; and three interactive features 4.1 percent of the time. However, I found that the number of interactive features per word did not significantly impact whether caregivers chose to talk about it, $X^2(2, N=730)=2.49, p=.29$. This means that caregivers were just as likely to talk about a new word that was highlighted by one interactive feature as they were to talk about a word with three interactive features.

Engagement with Interactive Features

The second question explored whether engaging with interactive features (i.e., tapping on the screen to activate it) impacted caregivers' word-related talk during the read-aloud sessions. Of the 786 new words highlighted by interactive features, 601 words required engagement from readers (76.5 percent), whereas the other 185 happened automatically (23.5 percent). I hypothesized that interactive features that required engagement might promote more word-related talk, as either the caregiver or child had to physically interact with the word by touching the screen. However, I found that interactive features that required engagement did not significantly influence whether caregivers talked about new words, $X^2(1, N=786)=0.35, p=.553$. In other words, caregivers were just as likely to talk about new words when interactive features happened automatically as they were when they were required to interact with the text.

Types of Interactive Features

The third question asked whether the types of interactive features influenced caregivers' word-related talk during the read aloud sessions. In the first study, I found four different types of interactive features in storybook apps: labeling (35.5 percent); visual supports (29.6 percent); definitions (18.5 percent); and viewer attention and interaction (17.7 percent). I hypothesized that viewer attention and interaction might promote more word-related talk, since this type of interactive feature draws readers' attention to new words in the text. However, I found that the types of interactive features did not influence the amount of caregivers' word-related talk, X^2(3, N=1,123)=0.87, p=.834. In other words, caregivers were just as likely to talk about words highlighted in purple font (viewer attention and interaction) as they were words with visual effects.

Types of Caregivers' Word-Related Talk

The final question examined whether the types of interactive features influenced the strategies caregivers used to talk about new words during the read aloud sessions. In the second study, caregivers used six different strategies to talk about new words: providing definitions (16.8 percent); giving examples (17.8 percent); pointing to pictures (50.5 percent); asking questions (10.9 percent); expanding utterances (3 percent); and making connections (2 percent). I hypothesized that new words with visual supports might result in more instances of caregivers pointing to pictures in the text, whereas labeling might prompt caregivers to say more about a new word – either by providing a definition or sharing examples with their child. However, I found that the types of interactive features did not influence the strategies caregivers used to talk about new words with their children, X^2(3, N=1,123)=0.87, p=.834. In other words, caregivers chose strategies independent of the types of interactive features in the text.

Summary of Findings

In summary, caregivers talked about roughly one word per story (1.03 words) – including words identified as "new" as well as those that were not. In both cases, caregivers were significantly more likely to talk about words with their children when they were highlighted by interactive features. When it came to the new words in the text, I found that the word-level features – parts of speech, frequency, and difficulty – did not significantly impact the words caregivers chose to talk about during the read-aloud sessions. In other words, caregivers were just as likely to talk about more common word types – such as nouns and verbs – as they were more challenging ones, such as prepositions or conjunctions. Similarly, caregivers talked about rare words and common words at similar rates, as well as words across all three levels of word difficulty. Taken together, this suggests that word-level features did not significantly influence caregivers' word-related talk during the read aloud sessions, and that something else – perhaps the interactive features – prompted caregivers to talk about a particular word.

Although caregivers talked about relatively few words overall – just 1.25 percent of all words in the texts – they used a range of strategies to do so. During the read aloud sessions, caregivers made 101 total talk moves and relied on six different strategies to talk about new words with their children: providing definitions, giving examples, pointing to pictures, asking questions, expanding utterances, and making connections. In most of these instances (80.7 percent), caregivers relied on just one strategy to talk about new words. However, caregivers also used multiple strategies with a single word nearly one-fifth of the time. Yet, despite the overall influence of interactive features on caregivers' word-related talk, I found that none of the factors explored in this study – including the number and types of interactive features in the text – impacted whether and how caregivers chose to talk about new words with their children. This means that one type or amount of interactive feature

was not more impactful than another, and that just the mere presence of interactive features might

promote more word-related talk while reading aloud.

CHAPTER 6 – DISCUSSION, IMPLICATIONS, AND CONCLUSIONS

Discussion

Arguably, one of the most important benefits of read alouds in the early years is the exposure children gain to new words. Books provide opportunities for children to expand their vocabulary in ways that are different than other experiences in their lives, such as playing with toys or conversations around the dinner table (Mol et al., 2009; Crain-Thoreson et al., 2001; Sorsby & Martlew, 1991; Weizman & Snow, 2001; Mesmer 2016). Although many early skills support later reading success, early vocabulary knowledge improves reading in several ways, including supporting comprehension of words that children decode; helping children recognize words more quickly; fostering phonological awareness skills; and increasing children's understanding of content-area instruction (National Early Literacy Panel, 2008). Long-term studies clearly indicate that stronger vocabulary skills in preschool are linked to better reading outcomes over time (e.g., Dickinson & Tabors, 2001).

However, the nature of interactive read alouds in young children's homes is evolving, as families are increasingly turning to digital texts from a very young age. Nearly 60 percent of families with children ages 0-8 engage in read alouds on a digital device at least once per day (Rideout & Robb, 2020), with 98 percent of families now owning either a smartphone or tablet (Rideout & Robb, 2020). However, no known studies have looked closely at the words children might encounter in preschool digital texts or the specific mechanisms unique to this context that draw attention to word learning experiences on the screen. To that end, the purpose of this dissertation study was to examine one type of preschool digital text – interactive storybook apps – for the affordances they may provide for young children's vocabulary development. To do so, I designed two separate but related studies.

In the first study, I conducted a content analysis (Hoffman et al., 2011; Krippendorff, 2013) of 70 best-selling preschool storybook apps to determine (a) the degree to which preschool storybook apps introduce new vocabulary words to young children; (b) the types of words children can learn from these texts; and (c) the degree to which interactive features in storybook apps highlight new words. Using the Words Worth Teaching List (Biemiller, 2009) as a guide, I analyzed 26,744 total words from these 70 apps to determine what percentage of words might be considered new for preschool-aged children. Furthermore, I described the types of words children might learn from these texts using three word-level features: parts of speech, frequency, and word difficulty. Finally, I adapted a coding scheme developed by Danielson, Wong, and Neuman (2019) to determine to what extent new words in storybook apps are highlighted by interactive features.

I found that, on average, 7.56 percent of the words in storybook apps might be considered new words for preschool-aged children. Most of the new words were verbs, nouns, or adjectives. However, the apps also contained new words across six other parts of speech: adverbs, modal verbs, prepositions, determiners, conjunctions, and pronouns. Approximately two-thirds of the new words occurred 50 or less times in the Parental Frequency Corpus (Han et al., 2005; MacWhinney, 2000; Wellman & Woolley, 1990) – with 13 percent of these words not occurring at all. Additionally, most of the new words fell into the second category of the Words Worth Teaching List (Biemiller, 2009): words to teach before second grade. However, approximately one-third of the new words fell into the two most challenging categories: words to teach before sixth grade and difficult words. Furthermore, on average, interactive features highlighted 23 percent of all new words in the text. The most common type of interactive feature used in storybook apps was labeling (47.6 percent), followed by visual supports (38.4 percent), and definitions (14 percent). Notably, I found that free and 99-cent storybook apps contained a similar percentage of new words, word types, and interactive features as apps priced higher than $1.00.

In the second study, I observed 37 caregivers of four- and five-year-old children to determine how interactive features closely aligned to new words in storybook apps might promote more word-related talk during read alouds. During this study, caregivers read four stories each – two print books and two storybook apps in counterbalanced order – for a total of 68,635 words in 148 sessions, totaling over 2,220 minutes of read aloud time. Overall, I found that caregivers relied on six different strategies to talk about words with their children: providing definitions, giving examples, pointing to pictures, asking questions, expanding utterances, and making connections. Although caregivers talked about relatively few words overall (just 1.25 percent of all words in the texts), they talked about significantly more new words when they were highlighted by interactive features. Notably, I found that the number of interactive features per word, engagement with the screen, and the types of interactive features did not significantly influence whether and how caregivers talked about a new word during the read aloud sessions.

In the following sections, I discuss these findings in relation to the empirical and theoretical literature on read alouds between caregivers and children in the home environment.

New Words in Preschool Texts

The findings in this study introduce important considerations to current thinking about digital texts and their potential for introducing new words to preschool-aged children. Although researchers frequently target children's vocabulary growth as an outcome in studies of interactive read alouds, they rarely give attention to the nature of the words in texts. Therefore, the purpose of the first study was to give focus to one element of the adult-child-book triad by exploring the degree to which preschool storybook apps contain new words for children of this age. In many ways, the findings from this study reiterated that texts written for preschool-aged children can introduce word learning opportunities into their everyday environment. The preschool storybook apps in my sample

contained an average of 7.56 percent of new words in the text. This amounts to a total of 1,970 new words and 1,376 unique new word types, for an average of approximately 20 new words per story.

Compared to previous studies of word learning opportunities in preschool texts, these results suggest that preschool storybook apps might be just as beneficial for children's word learning as print books – if not better. Mesmer (2016) identified an average of just 3.41 new words per story in her study of books in preschool classrooms – an average of nearly 17 fewer words than storybook apps – and found that approximately 19 percent of the books did not contain any new words at all. However, it is important to note that this study used the Dale-Chall list (Chall & Dale, 1995) to identify these new words and that this list might highly underestimate the number of new words in texts written for preschool children. While these numbers would likely be different using a method more aligned to preschool-aged children, it is unlikely that they would reflect the numbers found in storybook apps. For instance, every preschool storybook app in my sample contained at least one new word, and 83 percent contained five or more.

A better comparison is my previous study of preschool books found in children's homes (Bruner, 2021; Bruner, in press), where I used the Words Worth Teaching List (Biemiller, 2009) to identify new words in the texts. Using this list as a guide, I found that 6.87 percent of words might be considered new for preschool-aged children. On average, each text contained approximately 11 new words, with all but two books containing one or more. As such, the storybook apps in my sample contained 0.6 percent more new words and approximately nine more new words per story overall. This finding suggests that preschool storybook apps might contain a higher percentage of new words than print books found in children's homes, as well as introduce children to more new words per text. Similarly, I also found that the storybook apps in my sample that were designed from print books contained a significantly lower percentage of new words than the apps designed with original content.

Furthermore, although several early literacy researchers have extracted words from texts, few have further examined and described these words. As such, I analyzed the new words in preschool storybook apps for three word-level features: parts of speech, frequency, and word difficulty. First, I found that just 28 percent of new words in preschool storybook apps are nouns, which is different than other findings in the research literature: both Mesmer (2016) and I found that nearly half of the new words found in print books are nouns. Several studies have found that these words are relatively easier for young children to learn than other parts of speech, such as adjectives or adverbs (Beck & McKeown, 2001; Elley, 1989; Goodman, Dale, & Li, 2008; McDonough, Hirsh-Pasek, & Golinkoff, 2011). This suggests that many new words in storybook apps might be relatively difficult for young children to learn as compared to those found in print books. As such, children may need more support from caregivers when they encounter these new words, such as providing child-friendly explanations or referencing supportive elements within the texts themselves (e.g., images or interactive experiences).

Another factor that might influence how easily a word might be learned is the difficulty of the word. In this study, I relied on the categories from the Words Worth Teaching List (Biemiller, 2009), which classifies words into four groups: (1) easy words, or those that are known by most children at the end of second grade; (2) words to teach before second grade, which are known by 40-80 percent of children by the end of Grade 2; (3) words to teach before Grade 6, which are known by 40-80 percent of children by the end of sixth grade; and (4) difficult words, known by fewer than 40 percent of children by the end of Grade 6. I found that most of the new words in storybook apps fell into the second category: words to teach before second grade (67 percent). However, approximately one-third of the new words fell into the two most challenging categories: words to teach before sixth grade (25.5 percent) and difficult words (7.1 percent). In my study of preschool books in children's homes, I found nearly identical results: 65 percent of the new words

115

fell into the second category, 25 percent fell into the third category, and 10 percent fell into the fourth category. Similarly, Mesmer (2016) found that the new words in books found in preschool classrooms were evenly split between Tier-2 and Tier-3 words. This analysis of word difficulty suggests that, like print books, preschool storybook apps provide a balance between words that might be rapidly assimilated into young children's vocabulary and those that might require more support from caregivers.

Finally, children are more likely to learn words that they hear more frequently in their everyday environment (Naigles & Hoff-Ginsberg, 1998; Bates, Dale, & Thal, 1995; Goodman, Dale, Li, 2008; Massaro, 2016). In this study, I analyzed the frequency of the new words using the Parental Frequency Corpus (Han et al., 2005; MacWhinney, 2000; Wellman & Woolley, 1990) and found that approximately 39 percent of the words occurred five or less times – with 13 percent not occurring at all. This reflects previous findings in the research literature: Mesmer (2016) found that 49 percent of new words in preschool books occurred four or less times, whereas I found that 53 percent occurred five or less times. To put these findings into context, the numbers can be compared to the Word Zones standards, a listing that places words into "zones" by frequency (Hiebert & Fisher, 2007). *Highly frequent* words are those within the 930 most frequent words, *moderately frequent* words are those with frequencies of 10-99, and *infrequent words* are those with frequencies of 1-9. Hiebert and Fisher (2007) identified words as *rare* if they occurred less than one time per million. Using these definitions, 57 percent of the new words in storybook apps occurred less than ten times per million, indicating that most of the words identified would be considered *rare* or i*nfrequen*t by *Word Zones* standards. Like print books, these findings suggest that many new words in preschool storybook apps are unlikely to be words children have encountered frequently before in their everyday lives. This means it is particularly important they hear these words read aloud from texts that contain them.

One of the secondary aims of this study was to examine the affordances of preschool storybook apps for increasing access to texts. The goal is not to replace print texts in children's homes, but rather to capitalize on caregivers' increased access to smartphones and tablets to provide another avenue in which families can access books for free or at little cost. In this study, I explored the impact of both price and platform (i.e., Apple or Android) on the percentage of new words in the texts as well as the types of words children might learn from these stories. Notably, free and $0.99 apps contained a similar percentage of new words as apps at higher price points. Additionally, apps available through Android or both platforms also contained a similar percent of new words as apps available exclusively on Apple platforms, which typically cost more to own. These findings also hold true for the types of new words children might learn from these texts. Free and $0.99 apps, as well as apps available on either Android or both platforms, introduce children to similar types of new words across parts of speech, word frequency, and word difficulty as apps priced higher than $1.00 and those available exclusively through Apple. Taken together, these findings have exciting implications for equity as it relates to children's access to texts. Families with limited resources can gain access to children's stories that have many opportunities to learn new words through free and low-cost preschool storybook apps. Furthermore, families do not need to purchase expensive apps or tablets to read stories that will introduce their children to the types of challenging words they will need to become successful readers later in elementary school.

Amount and Types of Caregivers' Word-Related Talk

Interactive read alouds can help foster children's vocabulary skills, particularly when caregivers use texts as an opportunity to talk with their children about words (Arnold & Whitehurst, 1994; Whitehurst et al., 1988; Lonigan & Whitehurst, 1998; Zevenbergen & Whitehurst, 2003; Senechal, 2006; Mol et al., 2008; Hindman, Skibbe, & Foster, 2014). Caregivers in my study read a total of 68,635 words in four different stories across two read aloud sessions. Of these words, they

talked about 85 words that might be considered "new" for their preschool-aged children. These were words such as *nonchalant, disguise, gulped*, and *obstacles* that appeared in the second through fourth categories of the Words Worth Teaching List (Biemiller, 2009). Furthermore, caregivers also talked about 76 words that were not considered "new words." These were words such as *bored, tank, tapping,* and *storm* that appeared on the list of "easy" words; this also includes words such as *swabbing, sunblock, twitch*, and *slather* that were excluded from analysis because they did not appear in any category. In sum, caregivers talked about 161 total words during the read aloud sessions, or less than one percent of all the words in the texts (0.002). This aligns with previous studies that have found caregivers typically do not engage in shared conversations with their children around texts without instruction and support (Bus & vanIjzendoorn, 1995; Huebner, 2000a; Huebner & Melzoff, 2005; Evans, Reynolds, Shaw, & Pursoo, 2011) and that word-related talk, in particular, is a relatively uncommon occurrence (Dickinson & Tabors, 2001; Evans et al., 2011; Hindman et al., 2008; Hindman, Wasik, & Erhart, 2012).

As is typical in research on caregiver-child interactions (van Kleek et al., 1997; Weizman & Snow, 2001; Zimmerman et al., 2009; Troseth, 2020), there were individual differences in how much caregivers engaged their children in conversations about words. The number of words individual caregivers talked about ranged from a high of 21 words to a low of zero words. Twenty caregivers talked about more than three words, ten caregivers talked about one or two words, and seven caregivers did not talk about any words at all. Despite the relatively small sample size, I found that participant demographics (i.e., caregiver's education level, race or ethnicity, and relationship to the child), child demographics (i.e., child's age and sex), and the home literacy environment (i.e., number of print and digital books in the home and the number of times caregivers read aloud to their child per week) did not predict the number of words a caregiver might talk about with their child. Additionally, I found that the word-level features (i.e., parts of speech, word difficulty, and

frequency) also did not predict which words caregivers talked about during the read aloud sessions. Taken together, these findings are important because it suggests that participant demographics, child demographics, the home literacy environment, nor word-level features influenced caregivers' word-related talk. This means that something else besides these factors might have been impacting the words caregivers chose to talk about in the text.

In the instances that caregivers talked about new words, they relied on six different strategies to do so: providing definitions, giving examples, pointing to pictures, asking questions, expanding utterances, and making connections. In most of these instances (81 percent), caregivers relied on just one strategy to talk about new words. This aligns with previous studies that have found caregivers typically use just one approach to explain words to their children (Evans et al., 2011). The most common strategy caregivers used was to point to pictures in the text, which encompassed over half of all word-related talk that occurred in the study. This also aligns with previous studies that have found caregivers primarily label and describe the pictures in books while reading aloud (Dickinson & Tabors, 2001; Evans et al., 2011; Hindman et al., 2008; Senechal, 2006). However, while this type of talk is dominant in the research literature, as well as in this study, it has not been found to significantly impact children's vocabulary outcomes (Hindman et al., 2008; Hindman, Skibbe, & Foster, 2014). Notably, caregivers were more likely to point to pictures in storybook apps (68 percent) than in print books (32 percent).

The least common strategy used among caregivers was to expand their child's utterances about a new word (3 percent) and to make connections between new words in the text and other experiences in their children's lives (2 percent). This also aligns with previous studies that have found caregivers rarely engage in this type of meaning-focused talk during read alouds (Evans et al., 2011; Hindman et al., 2008; Hindman, Skibbe, & Foster, 2014). However, while it is relatively rare, this type of talk between caregivers and children has been found to have a positive impact on

119

children's language skills (Hindman et al., 2008; Hindman, Skibbe, & Foster, 2014; Senechal et al., 2008), particularly when caregivers relate story content to children's own lives and experiences (Hindman, Skibbe, & Foster, 2014). Notably, caregivers engaged in this type of talk significantly more while reading storybook apps (83 percent) than print books (17 percent). Caregivers also provided definitions and asked questions at similar rates as reported in the literature (Dickinson & Tabors, 2001; Evans et al., 2011; Hindman et al., 2008; Senechal, 2006). Furthermore, like Evans and colleagues (2011), when multiple strategies were used to explain a word (19 percent of instances), most often a definition of the word was combined with linking the meaning to the child's experience or the pictures in the story (84 percent).

Caregivers' Word-Related Talk in Print versus Digital Texts

The research literature is mixed on the benefits of digital texts for promoting meaning-focused interactions between caregivers and children. Several studies have found that conversations about the device itself dominate caregivers' talk during interactive read alouds with digital texts, with fewer instances of meaning-focused talk than when they share print books (Parish-Morris, 2013; Krcmar & Cingel, 2014; Munzer et al., 2019). Other studies have found the opposite: caregivers engaged in higher levels of conversational support while reading digital texts as compared to print books (Korat, Shamir, Heibel, 2013; Troseth et al, 2020), including more word-related talk (Korat and Or, 2010). In this study, caregivers each read two print book and two storybook apps, for a total of 74 stories in each format. Caregivers talked about 73 words while reading storybook apps and 85 words while reading print books, for an average of 0.99 words per storybook apps and 1.15 words per print book, a difference that is not statistically significant. This finding is important because it suggests that digital texts and print books elicit similar amounts of word-related talk. In other words, caregivers are just as likely to talk about new words with their children while reading storybook apps as they are print books. Therefore, while storybook apps might not elicit *more* talk than print books,

120

they also do not elicit *less*. However, I did not analyze the videos for other types of caregiver interactions. In absence of this, it is not possible to say how much time caregivers spent talking about words in both formats in relation to other types of talk, including topics not related to the story content such as making format-related comments (e.g., how to turn the page on the screen).

One possible explanation for the mixed findings in the research literature might be related to the congruence of the interactive features in digital texts. Two major research summaries – a meta-analysis (Takacs, Swart, & Bus, 2015) and a literature search that compared outcomes with effect sizes (Zucker, Moody, & McKenna, 2009) – concluded that interactive features, broadly defined, have a negative impact on children's learning when they are incongruent with stories' plot and main narrative. Yet, Korat and Or (2010) found that caregivers engaged in more word-related talk overall when interacting with a digital text in which the interactive features were aligned to difficult words in the story. Despite this, no known studies have looked closely at how these factors might relate to each other. Therefore, one of the major goals of this study was to identify the degree to which interactive features aligned to new words in storybook apps and how this might impact caregivers' interactions.

Overall, I identified 510 total interactive features in the 70 storybook apps. On average, interactive features highlighted approximately 23 percent of all new words. Thirteen apps (19 percent) did not highlight any new words with interactive features, whereas 30 apps (43 percent) highlighted 25 percent or more. This suggests that storybook apps vary widely in the number of new words that are highlighted by interactive features. The most common type of interactive feature was *labeling,* which was used with 46 percent of new words. This category included two different types of supports that identified words for readers: tapping a picture, in which a narrator named the item, and tapping on a word in the text, in which the narrator read it out loud. Given that the theory of synergy asserts that multiple presentations of words might facilitate deeper learning (Neuman, 1997),

the high percentage of new words that combine images and verbal messages within the text is a positive inclusion in storybook apps, as it might promote deeper word learning for children. Notably, Danielson, Wong, and Neuman (2019) did not identify any instances of labeling in preschool educational television media. This suggests that among different types of screen media, labeling might be a feature that is unique to digital texts.

Interestingly, I found that word-level features significantly influenced which words are highlighted by interactive features. Nouns and verbs were much more likely to be highlighted by interactive features than other parts of speech. Thirty-five percent of all new words that are nouns and 26 percent of new words that are verbs are highlighted by interactive features; adjectives and adverbs are highlighted less than 10 percent of the time, and other parts of speech, such as prepositions, conjunctions, and pronouns, are not highlighted at all. This is not surprising, given that concrete nouns (e.g., pearl, carousel, gown) and action verbs (e.g., strolling, dripping, gurgling) are easier to depict than pronouns such as *which* and *whom* or conjunctions such as *unless* or *nor*. However, studies have found that concrete nouns, as well as action verbs, are already easier for young children to learn than other parts of speech (Beck & McKeown, 2001; Elley, 1989; Goodman, Dale, & Li, 2008; McDonough, Hirsh-Pasek, & Golinkoff, 2011). Therefore, one recommendation for app developers might be to boost the number of more challenging word types – such as adjectives and adverbs – that are highlighted by interactive features. For instance, some of the more challenging word types that could be highlighted in the apps (but were absent in this analysis) include words such as *embarrassed, cozy, gentle, among, towards*, and *within.*

However, when it comes to difficult and rare words, storybook apps highlight the words that children need the most. For one, words that fall into the "difficult" category are significantly more likely to be highlighted by interactive features than words in other categories of the Words Worth Teaching List (Biemiller, 2009). This finding is important because it suggests that storybook apps are

122

providing readers with extra support around some of the most challenging words in the text. For instance, some of the "difficult" words highlighted by interactive features include *briskly,* in which a character walked quickly across the screen while a thunderstorm raged in the background; and *cavort* in which two characters held hands and danced together in a puddle. Likewise, the average frequency of words highlighted by interactive features (44.8) is significantly lower than the average frequency of words not highlighted by interactive features (108.2). In other words, storybook apps are highlighting words that children are less likely to hear often in their daily lives. Notably, nearly 40 percent of the new words with a frequency score of zero are highlighted by interactive features, along with another 36 percent of words with frequencies of five or less. Some examples of these words include *banish, betray, reassure*, and *bellow.*

As such, it is notable that words highlighted by interactive features elicited more word-related talk from caregivers than words that were not. Throughout the study, caregivers read a total 786 new words that were highlighted by interactive features and talked about 36 of them, or 4.58 percent of all words highlighted in the text. As mentioned previously, these words tended to be among some of the most challenging words in the apps; that is, words such as *levers, unique*, and *impressed* that were either words with lower frequency levels or words that fell into the "difficult" category of the Words Worth Teaching List (Biemiller, 2009). Taken together, these findings suggest that interactive features are prompting caregivers to talk about the types of challenging words in which children might need the most support.

Implications

The findings from this study have implications for teacher professional development, teacher preparation, community-based outreach programs, and app developers. In the following sections, I describe the implications of this study for each area.

Teacher Professional Development

Preschool texts can serve a variety of purposes for children's early literacy development: they can be used to spark children's excitement for reading; introduce the alphabet; help children play with sounds; and as shown in this study, introduce children to new words. However, texts cannot do all these things at the same time, and some texts may be better suited to these different purposes than others. Therefore, one implication of this study is that establishing a purpose for read alouds matters. While obvious, such differentiation of purpose is rarely seen in early childhood classrooms (Mesmer, 2016). Therefore, the first step in teacher professional development is to draw attention to selecting texts with a specific purpose in mind. The results in this study indicate that preschool storybook apps are ripe with opportunities to learn new words. As such, if a teacher's goal for a read aloud is vocabulary development or instruction, they should consider using preschool storybook apps alongside print books to accomplish this goal. The list of the top ten storybook apps with the highest percentage of new words (Table 13) might be a place for early childhood educators to start building their collection of texts rich with opportunities to talk about words with children.

The results from this study reveal that preschool storybook apps introduce children to many words they might have never heard before in their everyday environment. However, even though book reading is common in preschool settings, evidence suggests that vocabulary learning is simply not the focus very frequently. In Dickinson, McCabe, Anastasopoulos, Feinberg, and Poe (2003) teachers reported purposely teaching vocabulary during read alouds only one percent of the time, while in Stone and Twardosz (2001) teachers never identified vocabulary teaching as a reason to read books. Thus, part of the message to teachers might be to commit to reading aloud for vocabulary purposes regularly. Professional development sessions could focus on identifying target vocabulary to teach from texts while planning themed units and encouraging teachers to skim texts before reading to identify words to talk about with children. The focus on vocabulary does not mean that

124

other purposes could not simultaneously occur (e.g., enjoyment; phonological awareness), but it would give word learning a significant focus during read alouds. Through professional development, teachers can draw from these storybook apps and give focus to the new words within them.

Finally, another important avenue for professional development is supporting educators to help families add to their repertoire of strategies for promoting literacy at home, including providing families with texts that children can borrow or keep and suggestions for how to read with children in ways that support their language development. To accomplish both goals, teachers should consider providing families with a list of free and low-cost storybook apps that they can access at home on their smartphones or tablets. Findings from this study indicate that free and $0.99 storybook apps contain similar amounts of new words as their higher-priced counterparts, along with a similar distribution of new words across parts of speech, frequency, and difficulty levels, and a similar percentage of new words highlighted by interactive features, which in turn, might promote more word-related talk from caregivers – a crucial component of increasing children's word learning from texts (Arnold et al., 1994; Whitehurst et al., 1988; Lonigan & Whitehurst, 1998; Zevenbergen & Whitehurst, 2003; Senechal, 2006; Mol et al., 2008; Hindman, Skibbe, & Foster, 2014). Professional development activities might focus on supporting educators to capitalize on these features, including providing families with suggestions for how to talk about new words with their children in ways that boost their language development. Notably, preschool storybook apps are a particularly helpful resource for caregivers with low levels of literacy or for whom English is not their home language, as they provide an option to read the text aloud. In these instances, educators should encourage caregivers to listen to the story being read aloud alongside their children and talk with them about what they hear.

Teacher Preparation

Like teacher professional development, teacher preparation programs should place emphasis on supporting preservice educators to integrate vocabulary into read alouds. Helping beginning teachers understand the importance of this practice from the start of their career has the potential to impact practice as they enter the field. Relatedly, literacy methods courses should focus on teaching preservice educators to increase children's word learning from read alouds through research-based instructional practices. Best practices include rereading books, asking open-ended questions, connecting words to each other, providing child-friendly definitions, and using props and examples (Ehri & Robbins, 1994; Elley, 1989; Pan et al., 2005; Roberts & Neal, 2004; Sénéchal, 1997; Sénéchal & Cornell, 1993; Sénéchal, Thomas, & Monker, 1995). The research literature suggests that children respond differently to word learning opportunities and so, like many practices in the early childhood classroom, prospective teachers must learn the importance of knowing their students and what they bring to the read aloud experience (Ehri & Robbins, 1994; Hindman et al., 2008; Sénéchal, 1997; Sénéchal, Cornell, & Broda, 1995).

Furthermore, given the important role caregivers play during read alouds, teacher preparation programs must give focus to preparing preservice teachers to form partnerships with children's families and support their efforts to boost children's literacy learning at home. The research on parent involvement in schooling practices is overwhelmingly positive. For instance, in a longitudinal study of 704 parents in Chicago, Miedel and Reynolds (1999) found that while controlling for family background variables, the number of activities in which parents participated in while their children were in preschool and kindergarten was significantly related to higher reading achievement later in elementary school. Yet despite the importance of family involvement, teacher education programs have seldom included specific attention to the preparation of their teacher candidates to work effectively with families (D'Haem & Griswold, 2017). In their review of the

126

research, D'Haem and Griswold (2017) noted that most school administrators agreed that involving families was crucial for children's success in school, yet few believed that preservice teachers were fully prepared to do so. Similarly, Levine (2006) found that most principals felt their teachers were not prepared to work with caregivers once they entered the classroom. Furthermore, Patte (2011) found that while preservice educators were aware of the benefits of family involvement, 40 percent reported not learning any strategies for establishing family-school partnerships during their teacher preparation program. Given that caregivers play such a crucial role in children's early literacy development, preparing preservice teachers to partner with families should be at the forefront of every teacher preparation program.

Community-Based Outreach Programs

Studies have shown that access to print resources—board books, stories, and informational texts—early on in a child's development has both an immediate and long-term effect on their vocabulary development (Allington et al., 2010). Yet, many families lack access to children's texts in their communities (Neuman & Celano, 2001; Neuman & Moland, 2016). Research dating back to the 1980s has identified wide variability in both the quantity and quality of texts available for young children, particularly within low-income communities (Teale, 1986; Lareau, 1989; Neuman & Celano, 2001; Neuman & Moland, 2016). One solution that has not been widely explored is the role of digital texts in increasing access to texts in communities that have been historically under-resourced. Today, 98 percent of families own either a smartphone or a tablet (Rideout & Robb, 2020), making these devices a potential resource in which to provide access to children's texts.

As such, there are several crucial findings from this study that have important implications for programs that provide texts to children. First, the findings suggest that preschool storybook apps might contain a similar or even higher percentage of new words than print books, as well as introduce children to more new words per text. Furthermore, storybook apps elicit similar amounts

127

of talk from caregivers, which is a critical component of children's word learning (Arnold et al., 1994; Whitehurst et al., 1988; Lonigan & Whitehurst, 1998; Zevenbergen & Whitehurst, 2003; Senechal, 2006; Mol et al., 2008; Hindman, Skibbe, & Foster, 2014).). Finally, free and $0.99 storybook apps contain a similar percentage of new words as apps at higher price points, as well as a similar distribution of words across parts of speech, frequency, and word difficulty, and number of interactive features highlighting new words.

Taken together, storybook apps are a resource just waiting to be capitalized upon by community-based outreach programs. While internet access can be a barrier in families' homes, the internet is only needed for the initial download of the app; once the apps are on the device, it is not necessary to be connected to the internet to read them. Therefore, in the same spaces we provide free print books to children (e.g., schools, libraries, pediatrician's offices), we can provide free internet access for families to download apps. The lists of free and low-cost storybook apps (Appendix E) might be a place for community-based outreach programs to start building their collection of high-quality texts to provide for families.

Storybook App Developers

Finally, findings from this study have practical significance for app developers, who can use this information to design apps that promote and scaffold children's word learning. Collaboration between app developers and early childhood literacy researchers is currently lacking, yet it is crucial to develop materials that integrate word learning with digital features aligned to story content. One recommendation is for app developers to work with early literacy researchers to identify new words for preschool-aged children, especially those that might be more challenging for them to learn (e.g., adjectives and adverbs; words with lower frequencies). Early literacy researchers can use their expertise to recommend which words to highlight in the texts while app developers can use their digital design skills to create interactive features around these words. This type of collaboration

128

would ensure storybook apps provide an optimal learning experience for children, while not detracting from the enjoyment of reading together with a caregiver. Findings from this study indicate that the amount and types of interactive features does not influence whether and how caregivers talk with children about a particular word. However, further research is needed in this area, especially how these interactive features might impact children's word learning.

Finally, notably absent from preschool storybook apps are hotspots where caregivers and children can tap on a word to learn its meaning. This was surprising, especially given the number of times storybook apps label words in the text. Previous studies have found that hotspots that include explanations of difficult words are beneficial for children's word learning (Korat & Shamir, 2008; Smeets & Bus, 2014). Therefore, another recommendation for app developers is to build upon the labeling they already include in storybook apps to include child-friendly definitions of words. Again, storybook app developers can work with early literacy researchers to identify words that might benefit from a definition in the text, as well as how to explain the word in ways children will understand. Further research is needed to understand whether and how these hotspots might impact caregivers' interactions and children's word learning.

Limitations

There are several limitations to this study. First, the storybook apps from which I extracted new words were entirely of the narrative genre. Therefore, these findings cannot be generalized to other types of preschool storybook apps, such as informational stories. However, during the sampling procedures, I noted just seven storybook apps that met the study criteria but were not narrative texts. This suggests that while there are many narrative storybook apps available, there may not be an adequate number of storybook apps written in other genres (e.g., informational texts; alphabet books). This is problematic, as research suggests that different types of texts introduce children to different types of words (Bruner, 2021) and might elicit different amounts and types of

129

interaction from caregivers (Pellegrini et al., 1990; Sorsby & Martlew, 1991; Beals and Tabors, 1995; Neuman, 1996; Weizman & Snow, 2001).

Second, a relatively small number of families from one geographic location participated in this study, and they read just two stories each in print and digital formats in a contrived setting (i.e., through Zoom, typically sitting at a desk or table) while being recorded. To mitigate the impact of this, I assigned families to one of eight conditions in which the stories and the format (i.e., print or digital) was rotated in a counterbalanced order. In addition to turning off my own camera, I also gave families the option to turn off their camera if they preferred, although none of the families chose to do so. However, the small number of participants in each condition as well as the limited number of texts used in the study restricts the ability to generalize findings more broadly. A larger sample size is needed to achieve broader generalizations of these results.

Third, the caregivers who participated in this study were mostly White, well-educated mothers, likely due to the high response rate from the university-based parent listserv. The 2020 United States Census Bureau reports that 62 percent of the population is White and only 13 percent of the population holds an advanced degree. Therefore, the caregivers who participated in this study are not representative of the greater population, and as such, the findings cannot be generalized broadly. However, while the sample was skewed demographically, the child participants came from a full range of environments from which preschool children might be educated, including free and low-cost preschool programs (e.g., Head Start), for-profit childcare centers, in-home childcare settings, and home-based care from a primary caregiver (i.e., children not enrolled in a preschool program at the time of the study).

Finally, as discussed in Chapter 3, perhaps the greatest limitation of this study is that no child outcome data was collected. While several observational studies have not included child outcome data (e.g., Huebner & Meltzoff, 2005; Landry et al., 2012; Munzer et. al, 2019), the absence of this

information makes it difficult to evaluate whether the strategies caregivers used to talk about new words promoted children's vocabulary development. Therefore, unlike observational studies that found correlations between caregivers' talk and children's word learning (e.g., Strouse, O'Doherty, & Troseth, 2013; Korat, Shamir, & Heibal, 2013; Strouse & Troseth, 2014), the relationship between caregiver talk and children's word learning have not yet been examined in this study. The types of word-related talk caregivers used during the read aloud sessions are aligned with research suggesting they would promote vocabulary development, but more research is needed to determine if this is the case.

Future Research

Future research is needed to examine the affordances of using preschool storybook apps during read alouds between caregivers and children. The findings from this study suggest that interactive features elicit more word-related talk among caregivers than words without these supports. However, future studies should examine these findings with more nuance. One avenue rich for exploration is determining *who* is benefitting most from the interactive features in storybook apps. The relatively small number of families that participated in this study, coupled with the lack of diversity within the sample, meant that this type of differentiation was not possible in the current study. Future research is needed with a larger sample size and participants across a range of demographics to explore who profits most from interactive features while reading storybook apps aloud with their children.

Relatedly, studies have shown that caregivers are more likely to increase their interactions during read alouds when provided with guidance and suggestions on how to do so (Whitehurst et al., 1988; Arnold et al., 1994; Strouse et al., 2013; Bondt, Willenberg, & Bus, 2020). Furthermore, providing this type of support has a long-term impact on children's early literacy development, as evidence suggests that caregivers continue to use these techniques up to two years later (Huebner &

Payne, 2010). Therefore, another avenue for future research is to explore to what extent interactive features might serve as a *prompt* following an intervention, in which caregivers receive information about the importance of talking about words with their children and/or suggestions for how to do so. Prior research suggests that on-screen features, such as a character to model questioning techniques, increased caregivers' talk nearly three times as much as a text without these features (Troseth et al., 2020). As such, future research might explore to what extent interactive features might serve a similar purpose.

Additionally, while findings from this study suggest that print and digital texts elicit similar amounts of word-related talk, I did not examine what other types of interactions occurred during the read aloud sessions. Therefore, future studies with preschool storybook apps should explore these interactions in more detail, including the amount of time caregivers spend reading stories in both formats and the type of talk caregivers engage in with these texts. Prior research in this area is mixed, with some studies suggesting that caregivers spend more time talking about the device than story-related content (e.g., Parish-Morris, 2013; Krcmar & Cingel, 2014; Munzer et al., 2019) while others suggest the opposite is true (e.g., Korat and Or, 2010; Korat, Shamir, Heibel, 2013; Troseth et al, 2020). Further analyzing the data collected as a part of this study might help shed light on these findings.

Finally, future studies should examine children's vocabulary outcomes during read alouds of digital texts to determine whether and how interactive features impact children's word learning. Studies involving children of various ages 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, & de Jong, 2009; Ihmeideh, 2014) with digital texts as compared to print books. In one study, children who struggled with phonological awareness caught up to and surpassed children who were learning on grade-level due

to their motivation to listen and practice word pronunciations using well-designed interactivity (Littleton, Wood, & Chera, 2006). However, little is known about how interactive features might support children's word learning from texts, both in tandem with caregivers' interaction and while reading text by themselves. This area of research holds great potential for children and families alike.

Conclusions

As highlighted by the framing of this study, read alouds of preschool storybook apps are interactive events in which the words in the story, the features of the text, and the interactions between children and caregivers work together in one cohesive whole. However, it is the words in the text – and the features embedded within it – that serve as the basis for interactions that occur between caregivers and children. The availability of new words in the text means that children have an opportunity to learn a word they did not know before, but it is the adults reading the texts that hold the key to unlock its meaning. Not only are preschool storybook apps ripe with opportunities to learn new words, but they invite children to learn words across many different parts of speech, words they might have never heard before, and the types of challenging words they will encounter in texts throughout elementary school. Furthermore, the interactive features aligned to these new words in storybook apps promote more word-related talk from caregivers, which is a crucial component of children's word learning from text (Arnold & Whitehurst, 1994; Whitehurst et al., 1988; Lonigan & Whitehurst, 1998; Zevenbergen & Whitehurst, 2003; Senechal, 2006; Mol et al., 2008; Hindman, Skibbe, & Foster, 2014). With the rise of smartphones and tablets in children's homes, and their increased usage from caregivers as a mechanism in which access stories, storybook apps are untapped resource just waiting to be unlocked.

APPENDICES

APPENDIX A – LIST OF SAMPLE PRESCHOOL STORYBOOK APPS

Table 32

Study 1: List of Sample Preschool Storybook Apps

Title	Platform	Price
Another Monster at the End of This Book	Apple; Amazon	$3.99
Barnyard Dance!	Apple; Amazon	$2.99
Blue Hat, Green Hat	Apple; Google Play	$2.99
Boats (Byron Barton)	Apple	$1.99
Bubble Guppies: A Grumpfish Tale	Apple; Google Play; Amazon	$0.99
But Not the Hippopotamus	Apple; Google Play	$2.99
Care for Our World	Apple	$0.00
Cat Alvin	Amazon	$0.99
Caillou the Dinosaur Hunter	Apple	$2.99
Caillou's Castle	Apple	$2.99
Caillou's Road Trip	Apple	$2.99
Cozmo's Day Off	Apple	$0.99
Crepes by Suzette	Apple; Amazon	$2.99
Even Monsters Are Shy	Apple	$0.99
Even Monsters Get Sick	Apple; Google Play; Amazon	$0.99
Five Little Monkeys Jumping on the Bed	Apple; Google Play	$2.99
Five Little Monkeys Sitting in a Tree	Apple; Google Play; Amazon	$2.99
Five Little Monkeys with Nothing to Do	Apple; Google Play	$2.99
Goodnight Moon	Apple; Amazon	$4.99
Goodnight, Goodnight Construction Site	Apple	$3.99
Grandma's Great Gourd	Apple	$1.99
Green Eggs and Ham	Apple; Google Play; Amazon	$5.99
How I Became a Pirate	Apple; Amazon: Google Play	$3.99
Kalley's Machine Plus Cats	Apple; Amazon	$0.99
Leo the Lightning Bug	Apple; Amazon	$2.99
Little Critter: All by Myself	Apple; Google Play; Amazon	$1.99

Table 32 (cont'd)

Title	Platform	Price
Little Critter: I Was So Mad	Apple; Google Play; Amazon	$1.99
Little Critter: Just My Friend and Me	Apple; Amazon	$1.99
Moo, Baa, La La La!	Apple; Amazon	$2.99
Mr. Fox & Mr. Rabbit	Apple	$0.00
My Little Pony: Best Pet	Apple; Amazon	$2.99
My Little Pony: Cutie Pox	Apple; Amazon	$2.99
My Little Pony Party of One	Apple; Amazon	$2.99
My Little Pony: The Movie	Apple; Google Play; Amazon	$2.99
Nighty Night Construction Trucks	Apple; Amazon	$2.99
Nighty Night Zoo	Apple; Amazon	$2.99
One Fish, Two Fish	Apple; Google Play; Amazon	$3.99
Oobie's Space Adventure	Apple	$0.00
Pat the Bunny	Apple; Google Play	$2.99
Pen Eats Out	Amazon	$0.00
Pete's Robot	Apple	$0.00
Planes (Byron Barton)	Apple	$1.99
Polar Bear Horizon	Apple; Amazon	$2.99
Red Fox at Hickory Lane	Apple; Amazon	$2.99
Snowy and Chinook's Birthday Invite	Apple	$1.99
Sunny's Dark Night	Apple	$1.99
Tacky and the Winter Games	Apple; Amazon	$3.99
Tacky Goes to Camp	Amazon; Google Play	$3.99
Tacky the Penguin	Amazon: Google Play	$3.99
The Artist Mortimer	Apple	$0.00
The Artist Mortimer 2	Apple	$0.99
The Berenstain Bears Bedtime Battle	Apple; Google Play; Amazon	$3.99
The Berenstain Bears Come Clean for School	Apple; Google Play	$3.99
The Berenstain Bears Really Big Pet Show	Apple; Google Play	$3.99
The Cat in the Hat	Apple; Google Play; Amazon	$5.99
The Caterpillar and the Ladybug	Apple	$0.99

Table 32 (cont'd)

Title	Platform	Price
The Going to Bed Book	Apple; Google Play; Amazon	$3.99
The Icky Mr. Fox	Both	$0.00
The Kissing Hand	Apple; Google Play; Amazon	$3.99
The Monster at the End of this Book	Apple; Google Play; Amazon	$4.99
The Snow Fox	Apple	$0.00
The Tale of Benjamin Bunny	Apple; Google Play; Amazon	$3.99
The Tale of Peter Rabbit	Apple; Google Play; Amazon	$3.99
The Tale of Squirrel Nutkin	Apple; Google Play; Amazon	$4.99
Trains (Byron Barton)	Apple	$1.99
Trucks (Byron Barton)	Apple	$1.99
Wee Alphas	Apple	$2.99
Wee You-Things	Apple	$2.99
Windy's Lost Kite	Apple	$1.99
Woolly Mammoth in Trouble	Apple; Amazon	$1.99

CALLING ALL PRESCHOOL FAMILIES!

DO YOU HAVE A CHILD AGES 4-5 YEARS OLD?

We would like to invite you and your child to help us learn more about preschool storybook apps!

As a part of this study, we will ask you to: Complete a short background survey & read four stories to your child in two, 30-minute recorded Zoom sessions

As a participant, please have access to: A tablet (any model), an internet connection, and one extra device to access Zoom (ex: laptop or cell phone)

As a thank you, you will receive: A $50 gift card, two children's books, and two preschool storybook apps

Interested in Participating? Please contact Lori Bruner, Doctoral Candidate in Teacher Education: Lbruner@msu.edu

Michigan State University Institutional Review Board Approved: Study #0005845

APPENDIX C – PARTICIPANT BACKGROUND SURVEY

Part I: Informed Consent

Thank you so much for sharing your time with me! To get started, please read the attached consent form. If you are willing to participate, please type your name below, write today's date, and check "agree."

The survey should take approximately five minutes to complete. You will only be asked to complete this survey one time. You can enter and exit the survey as many times as you need to complete it.

[Click here to view the consent form]

By typing my first and last name below, I am agreeing to the terms of the study outlined in the consent form: [Box to enter first and last name]

Please type the date in which you are agreeing to the terms of the consent form: [Box to enter date in MM/DD/YYYY]

I have read the attached consent form carefully and would like to participate in this study with my child: [Box to check agree]

Part II: Demographic Information

1. What is your child's first name? [Box to type child's first name]

2. What is your child's date of birth (MM/DD/YYYY)? [Box to enter birthdate]

3. What is your relationship to the child participating in the study with you? [Box to type relationship to child]

4. What is your age?
   - 18-26
   - 27-35
   - 36-44
   - 45-53
   - 54-62
   - 63-71
   - 72 and over
   - Prefer not to answer

5. What is the highest education level you've completed?
   - Some high school
   - High school diploma or GED
   - Some college courses
   - Associates Degree (AA, AS)

- Four-year degree (BA, BBA, BS)
- Master's Degree (MA, MS)
- Professional Degree (MD, DDS, JD)
- Doctorate Degree (PhD, EdD)
- Other (please write)
- Prefer not to answer

6. Please check the category that best describes your race or ethnicity:
   - American Indian/Alaskan Native (non-Hispanic)
   - Asian (non-Hispanic)
   - Asian/Pacific Islander
   - Black or African American (non-Hispanic)
   - Hawaiian/Pacific Islander (non-Hispanic)
   - Hispanic Ethnicity
   - Two or more races (non-Hispanic)
   - White (non-Hispanic)
   - Other (non-Hispanic)
   - Prefer not to answer

7. Please provide an e-mail address where you can receive regular communication throughout the study: [Box to provide e-mail address]

Part III: Home Literacy Environment

8. Approximately how many children's picture books are **in your home**, including library books and/or books borrowed from your child's school or another source?
   - 0-10
   - 11-20
   - 21-30
   - 31-40
   - 41-50
   - More than 50
   - I'm not sure

9. During an average week, how often does your child look at picture books with you or another adult **at home?**
   - My child doesn't look at picture books often
   - Once or twice
   - Three to six times
   - Every day
   - I'm not sure

10. Approximately how many children's digital books are **in your home**, including digital books borrowed from the library or as a part of your child's school or another source?
    - 0-10
    - 11-20

- 21-30
- 31-40
- 41-50
- More than 50
- I'm not sure

11. During an average week, how often does your child look at digital books with you or another adult **at home?**
    - My child doesn't look at digital books often
    - Once or twice
    - Three to six times
    - Every day
    - I'm not sure

12. How old was your child when they first interacted with an app on a tablet (rounded to the nearest half year)? [Box to write in child's age]

13. What type of tablet will you be using as a participant in the study (e.g., iPad; Amazon Fire HD 8 Kids)? [Box to enter type of tablet]

Part IV: Survey End

14. Is there anything else you would like to share related to this study? [Box to type response]

Table 33

Words Discussed by Caregivers: Kalley's Machine Plus Cats

Word	New Word (Yes/No)	Interactive Features	Parts of Speech	Word Frequency	Word Difficulty
Dials (10)	Yes	Yes	Noun	N/A	Difficult
Levers (6)	Yes	Yes	Noun	5	6th Grade
Nonchalant (4)	Yes	No	Adjective	0	Difficult
Shapes (3)	Yes	Yes	Noun	N/A	2nd Grade
Controls (3)	Yes	Yes	Noun	N/A	Difficult
Stamps (1)	Yes	Yes	Verb	N/A	2nd Grade
Puff (1)	Yes	No	Verb	N/A	2nd Grade
Crank (6)	No	Yes	Noun	N/A	Easy
Poke (2)	No	Yes	Verb	39	Easy
Faking (2)	No	No	Verb	3	N/A
Shrink (2)	No	Yes	Verb	4	Easy
Turn (1)	No	Yes	Verb	4	Easy

Note. The number of times caregivers talked about each word is listed in parentheses in the word column. A designation of "N/A" in the frequency column means the word was excluded from the analysis; a designation of "N/A" in the word difficulty column means the word was not listed on the *Words Worth Teaching List.*

Table 34

Words Discussed by Caregivers: Even Monsters Get Sick

Word	New Word (Yes/No)	Interactive Features	Parts of Speech	Word Frequency	Word Difficulty
Spookiest (5)	Yes	Yes	Adjective	0	2nd Grade
Disguise (4)	Yes	No	Verb	4	6th Grade
Twinkle (3)	Yes	Yes	Noun	25	2nd Grade
Toes (2)	Yes	Yes	Noun	110	2nd Grade
Soup (2)	Yes	Yes	Noun	234	2nd Grade
Temperature (1)	Yes	No	Noun	47	2nd Grade
Gurgled (1)	Yes	Yes	Verb	0	2nd Grade
Goo (1)	Yes	No	Noun	9	2nd Grade
Hide (1)	Yes	No	Verb	193	2nd Grade
Tapping (3)	No	Yes	Verb	3	Easy
Growled (2)	No	Yes	Verb	1	Easy
Bored (2)	No	Yes	Adjective	22	Easy
Sneezed (2)	No	Yes	Verb	23	Easy
Twitch (2)	No	Yes	Verb	1	N/A
Treasure (1)	No	No	Noun	14	Easy

Note. The number of times caregivers talked about each word is listed in parentheses in the word column. A designation of "N/A" in the frequency column means the word was excluded from the analysis; a designation of "N/A" in the word difficulty column means the word was not listed on the *Words Worth Teaching List*.

Table 35

Words Discussed by Caregivers: How I Became a Pirate

Word	New Word (Yes/No	Interactive Features	Parts of Speech	Word Frequency	Word Difficulty
Gulped (3)	Yes	Yes	Verb	2	2nd Grade
Hatches (2)	Yes	Yes	Noun	N/A	6th Grade
Chest (2)	Yes	Yes	Noun	N/A	2nd Grade
Teeth (1)	Yes	Yes	Noun	470	2nd Grade
Pounded (1)	Yes	No	Verb	N/A	2nd Grade
Crossbones (1)	Yes	No	Noun	0	Difficult
Tuck (1)	Yes	No	Verb	20	2nd Grade
Swabbing (8)	No	No	Verb	0	N/A
Sunblock (5)	No	Yes	Noun	2	N/A
Slathering (2)	No	No	Verb	0	N/A
Yonder (1)	No	No	Adverb	0	N/A
Treasure (1)	No	Yes	Noun	14	Easy
Storm (1)	No	Yes	Noun	N/A	Easy
Roared (1)	No	Yes	Verb	N/A	Easy
Yelled (1)	No	Yes	Verb	22	Easy
Skull (1)	No	No	Noun	3	Easy

Note. The number of times caregivers talked about each word is listed in parentheses in the word column. A designation of "N/A" in the frequency column means the word was excluded from the analysis; a designation of "N/A" in the word difficulty column means the word was not listed on the *Words Worth Teaching List*.

Table 36

Words Discussed by Caregivers: My Little Pony Best Pet

Word	New Word (Yes/No)	Interactive Features	Parts of Speech	Word Frequency	Word Difficulty
Obstacles (4)	Yes	No	Noun	0	6th Grade
Participating (3)	Yes	Yes	Verb	1	2nd Grade
Prickly (2)	Yes	No	Adjective	8	Difficult
Unique (2)	Yes	Yes	Adjective	4	6th Grade
Impressed (2)	Yes	Yes	Adjective	10	2nd Grade
Excited (2)	Yes	Yes	Adjective	65	2nd Grade
Guts (2)	Yes	No	Noun	N/A	2nd Grade
Helped (2)	Yes	No	Verb	53	2nd Grade
Introduced (1)	Yes	Yes	Verb	3	2nd Grade
Announced (1)	Yes	Yes	Verb	3	2nd Grade
Strolling (1)	Yes	Yes	Verb	1	2nd Grade
Thorns (1)	Yes	No	Noun	5	2nd Grade
Challenged (1)	Yes	Yes	Verb	5	6th Grade
Cool (1)	Yes	No	Adjective	N/A	2nd Grade
Style (1)	Yes	No	Noun	N/A	Difficult
Gorge (3)	Yes	No	Noun	N/A	Difficult
Radical (3)	Yes	No	Adjective	N/A	Difficult
Tank (2)	No	No	Noun	N/A	N/A
Helicopter (2)	No	Yes	Noun	88	Easy
Trapped (2)	No	Yes	Verb	9	N/A
Tortoise (2)	No	Yes	Noun	20	N/A
Navigate (2)	No	No	Verb	2	N/A
Avalanche (2)	No	Yes	Noun	0	Easy

Table 36 (cont'd)

Word	New Word (Yes/No)	Interactive Features	Parts of Speech	Word Frequency	Word Difficulty
Agility (2)	No	Yes	Noun	0	N/A
Contestants (1)	No	Yes	Noun	1	N/A
Picky (1)	No	No	Adjective	2	N/A
Affection (1)	No	No	Noun	1	N/A

Note. The number of times caregivers talked about each word is listed in parentheses in the word column. A designation of "N/A" in the frequency column means the word was excluded from the analysis; a designation of "N/A" in the word difficulty column means the word was not listed on the *Words Worth Teaching List*.

Table 37

List of Free and $0.99 Preschool Storybook Apps

Storybook App Title	App Platform	Total Price	Unique New Words	% New Words	% Interactive Features
Oobie's Space Adventure	Apple	$0	5	13.5	60.0
Pete's Robot	Apple	$0	21	13.0	17.7
Mr. Fox and Mr. Rabbit	Apple	$0	10	9.2	9.1
Care for Our World	Apple	$0	16	8.7	27.3
Icky Mr. Fox	Both	$0	11	8.1	38.9
Pen Eats Out	Android	$0	6	7.9	15.4
The Snow Fox	Apple	$0	8	7.0	0
The Artist Mortimer	Apple	$0	8	5.2	37.5
Cozmo's Day Off	Apple	$0.99	27	13.5	0
Kalley's Machines Plus Cats	Both	$0.99	24	12.1	21.2
The Caterpillar & Ladybug	Apple	$0.99	14	9.3	20.0
The Artist Mortimer 2	Apple	$0.99	20	7.9	18.2
Cat Alvin	Android	$0.99	30	6.8	10.9
Even Monsters Get Sick	Both	$0.99	21	6.6	20.0
A Grumpfish Tale	Both	$0.99	12	4.6	0.0
Even Monsters are Shy	Apple	$0.99	20	4.6	19.1

Note. A designation of "both" in the platform column indicates the storybook app is available on both Android and Apple platforms.

REFERENCES

REFERENCES

Children's Literature Cited

Brown, M. W. (2017). *Goodnight Moon*. London: Two Hoots. (Original work published 1947)

Hollenbeck, K.M. (2004). *Red Fox at Hickory Lane*. Norwalk, CT: Sounprints.

Kunhardt, D. (2001). *Pat the Bunny*. New York: Random House Children's Books. (Original work published 1940)

Long, M. & Shannon, D. (2003). *How I Became a Pirate*. New York: HarperCollins Publishers.

Penn, A. (1993). The Kissing Hand. Indianapolis, IN: Tanglewood Press.

Potter, B. (2002). *The Tale of Peter Rabbit*. London: Warne. (Original work published 1901)

References

Allington, R., McGill-Franzen, A., Williams, L., Camilli, G., & Graff, J. (2010). Addressing Summer Reading Setback Among Economically Disadvantaged Elementary Students. *Reading Psychology, 31*, 411-427.

Amendum, S.J., Conradi, K., & Hiebert, E.F. (2017). Does Text Complexity Matter in the Elementary Grades? A Research Synthesis of Text Difficulty and Elementary Students' Reading Fluency and Comprehension. *Educational Psychology Review, 30*(1), 121-151.

Anderson, N.J., Graham, S.A., Prime, H., Jenkins, J.M., Madigan, S. (2021). Linking Quality and Quantity of Parental Linguistic Input to Child Language Skills: A Meta-Analysis. *Child Development, 92*(2) 484-501.

Anderson, R. C., & Freebody, P. (1981). Vocabulary knowledge. In J. T. Guthrie (Ed.), *Comprehension and teaching: Research reviews* (pp. 77–117). International Reading Association.

Arnold, D. H., Lonigan, C. J., Whitehurst, G. J., & Epstein, J. N. (1994). Accelerating language development through picture book reading: Replication and extension to a videotape training format. *Journal of Educational Psychology, 86*(2), 235–243.

Bates, E., Dale, P., & Thal, D. (1995). Individual differences and their implications for theories of language development. In P. Fletcher and B. MacWhinney (Eds.), *Handbook of child language* (pp. 95-151). Oxford: Blackwell.

Beals, D. E. (1997). Sources of support for learning words in conversation: Evidence from mealtimes. *Journal of Child Language, 24*(3), 673–694.

Beals, D. E., & Tabors, P. O. (1995). Arboretum: bureaucratic and carbohydrates: preschoolers' exposure to rare vocabulary at home. *First Language, 15*, 57–76.

Beck, I. L., & McKeown, M. G. (2001). Text talk: capturing the benefits of read-aloud experiences for young children. *The Reading Teacher, 55*(1), 10–20.

Beck, I. L., McKeown, M. G., & Kucan, L. (2002). *Bringing words to life: robust vocabulary instruction. Solving problems in the teaching of literacy.* New York, NY: Guilford.

Beck, I. L., McKeown, M. G., & Kucan, L. (2008). *Creating robust vocabulary: frequently asked questions and extended examples.* New York, NY: Guilford.

Biemiller, A. (2009). *Words Worth Teaching: Closing the Vocabulary Gap.* Chicago: SRA.

Biemiller, A., & Slonim, N. (2001). Estimating root word vocabulary growth in normative and advantaged populations: evidence for a common sequence of vocabulary acquisition. *Journal of Educational Psychology, 93*(3), 498–520.

Bohannon, J. N., & Bonvillian, J. D. (2001). Theoretical approaches to language acquisition. In J. B. Gleason (Ed.), *The development of language* (5th ed., pp. 254–314). Allyn and Bacon.

Bruner, J. (1978). The role of dialogue in language acquisition. In A. Sinclair, R. Jarvella, & W. Levelt (Eds.), The child's conception of language. Springer-Verlag.

Bruner, L. (2021). A Well-Rounded Diet: Fueling Children's Vocabulary Development. *The Reading Teacher*, *74*(6), 570-579.

Brysbaert, M. (2019). How many words do we read per minute? A review and meta-analysis of reading rate. *Journal of Memory and Language, 109,* Article 104047.

Burgess, S. R., & Lonigan, C. J. (1998). Bidirectional relations of phonological sensitivity and prereading abilities: Evidence from a preschool sample. *Journal of Experimental Child Psychology, 70*, 117–141.

Burnett, C. (2010) Technology and literacy in early childhood educational settings: A review of the research. *Educational Psychology Review, 14*, 5-26.

Bus, A.G. & van Ijzendoor, M.H. (1995). Mothers reading to their 3-year-olds: The role of mother-child attachment security in becoming literate. *Reading Research Quarterly, 30*(4) 998-1015.

Bus, A. G., IJzendoorn, M. H., & Pellegrini, A. D. (1995). Joint book reading makes for success in learning to read: a meta-analysis on intergenerational transmission of literacy. *Review of Research in Education, 65*, 1–21.

Bus, A. G., Verhallen, M. J. A. J., & de Jong, M. T. (2009). How onscreen storybooks contribute to early literacy. In A. G. Bus & S. B. Neuman (Eds.), *Multimedia and literacy development: Improving achievement for young learners* (pp. 153–167). New York, NY: Routledge Education; Taylor & Francis Group.

Bus, A. G., Takacs, Z. K., & Kegel, C. A. T. (2015). Affordances and limitations of electronic storybooks for young children's emergent literacy. *Developmental Review, 35,* 79–97.

Bus, A.G., Neuman, S.B., & Roskos, K. (2020). Screens, Apps, and Digital Books for Young Children: The Promise of Multimedia. *AERA Open, 6*(1), 1-6.

Cervetti, G. N., Hiebert, E. H., Pearson, P. D., & McClung, N. A. (2015). Factors that influence the difficulty of science words. *Journal of Literacy Research, 47*(2), 153–185.

Chall, J. S., & Dale, E. (1995). *Readability revisited: the new Dale–Chall readability formula.* Cambridge, MA: Brookline Books.

Chera, P., & Wood, C. (2003). Animated multimedia "talking books" can promote phonological awareness in children beginning to read. *Learning and Instruction, 13*(1), 33–52.

Child Language Date Exchange System (2014). CHILDES Parental Corpus. Retrieved from http://childes.psy.cmu.edu/topics/parentfreq.doc.

Christ, T., Wang, X. C., Chiu, M. M., & Strekalova-Hughes, E. (2019). How app books' affordances are related to young children's reading behaviors and outcomes. In A. Bus, S. B. Neuman, & K. Roskos (Eds.). *American Educational Research Association Open*, Special Issue: *Screens, Apps, and Digital Books for Young Children: The Promise of Multimedia, 5*(2).

Collins, M. F. (2010). ELL preschoolers' English vocabulary acquisition from storybook reading. *Early Childhood Research Quarterly, 25*(1), 84–97.

Compton, D. L., Appleton, A. C., & Hosp, M. K. (2004). Exploring the relationship between text-leveling systems and reading accuracy and fluency in second-grade students who are average and poor decoders. *Learning Disabilities Research & Practice, 19*, 176–184.

Crain-Thoreson, C., Dahlin, M. P. and Powell, T. A. 2001. "Parent-child interaction in three conversational contexts: Variations in style and strategy.". In *Sourcebook on emergent literacy*, Edited by: Brooks-Gunn, J. and Rebello, P. 23–38. San Francisco: Jossey-Bass.

D'Haem, J., & Griswold, P. (2017). Teacher educators' and student teachers' beliefs about preparation for working with families including those from diverse socioeconomic and cultural backgrounds. *Education and Urban Society, 49*(1), 81–109.

Danielson, K., Wong, K.M., & Neuman, S.B. (2019). Vocabulary in Educational Media for Preschoolers: A Content Analysis of Word Selection and Screen-Based Pedagogical Supports. Journal of Children and Media, 13(3), 345-362.

de Bondt, M., Willenberg, I. A., & Bus, A. G. (2020). Do Book Giveaway Programs Promote the Home Literacy Environment and Children's Literacy-Related Behavior and Skills? *Review of Educational Research*, *90*(3), 349-375.

de Jong, M. T., & Bus, A. G. (2003). How well suited are electronic books to supporting literacy? *Journal of Early Childhood Literacy, 3*(2), 147–164.

DeTemple, J., & Snow, C. (2003). Learning words from books. In K. van Kleeck, S. Stahl, & E. Bauer (Eds.), *On reading books to children* (pp. 16–36). Mahwah, NJ: Erlbaum.

Dickinson, D. K., & Tabors, P. O. (1991). Early literacy: Linkages between home, school and literacy achievement at age five. *Journal of Research in Childhood Education, 6*(1), 30– 46.

Dickinson, D. K., & Tabors, P. O. (Eds.). (2001). *Beginning literacy with language: Young children learning at home and school.* Paul H Brookes Publishing.

Dickinson, D. K., McCabe, A., & Anastasopoulos, L. (2003). A framework for examining book reading in early childhood classrooms. In K. van Kleeck, S. Stahl, & E. Bauer (Eds.), *On reading books to children* (pp. 95–113). Mahwah, NJ: Erlbaum.

Dickinson, D., McCabe, A., Anastasopoulos, L., Feinberg, E. S., & Poe, M. D. (2003). The comprehensive language approach to early literacy: the interrelationship among vocabulary, phonological sensitivity, and print knowledge among preschool-aged children. *Journal of Educational Psychology, 95*, 465–481.

Dickinson, D. K., Hofer, K. G., Barnes, E. M., & Grifenhagen, J. F. (2014). Examining teachers' language in Head Start classrooms from a Systemic Linguistics Approach. *Early Childhood Research Quarterly, 29*(3), 231–244.

Dore, R. A., Hassinger-Das, B., Brezack, N., Valladares, T. L., Paller, A., Vu, L., Golinkoff, R. M., & Hirsh-Pasek, K. (2018). The parent advantage in fostering children's e-book comprehension. *Early Childhood Research Quarterly, 44,* 24–33.

Ehri, L., & Robbins, C. (1994). Does reading storybooks to kindergarteners help them learn new vocabulary words? *Journal of Educational Psychology, 86*(1), 54–65.

Elleman, A.M., Steacy, L.M., Olinghouse, N.G., & Compton, D.L. (2017). Examining Child and Word Characteristics in Vocabulary Learning of Struggling Readers. *Scientific Studies of Reading, 21*(2), 133-145.

Elley, W. B. (1989). Vocabulary acquisition from listening to stories. *Reading Research Quarterly, 24*, 174–187.

Evans, M. A., Shaw, D., & Bell, M. (2000). Home literacy activities and their influence on early literacy skills. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale, 54*(2), 65–75.

Guernsey, L., Levine, M., Chiong, C., & Severns, M. (2012). *Pioneering literacy in the digital wild west: Empowering parents and educators.* New York, NY: The Joan Ganz Cooney Center at Sesame Workshop. Retrieved from http://www.joangan-zcooneycenter.org/wp-content/uploads/2012/12/GLR_TechnologyGuide_final.pdf

Goodman, J.C., Dale, P.S., & Li, P. (2008). Does frequency count? Parental input and the acquisition of vocabulary. *Journal of Child Language, 35*(3), 515-531.

Gonzalez, J.E., Pollard-Durodola, S., Simmons, D.C., Taylor, A., Davis, M.J., Kim, M., and Simmons, L. (2011). Developing Low-Income Preschoolers' Social Studies and Science Vocabulary Knowledge Through Content-Focused Shared Book Reading. *Journal of Research on Educational Effectiveness, 4*, 25-52.

Grifenhagen, J. (2012). *Nurturing Word Learners: Children's Opportunities for Vocabulary Learning in Head Start Classrooms*. Retrieved from: https://etd.library.vanderbilt.edu/available/etd-11272012-132257/unrestricted/Grifenhagen.pdf

Han, M., Roskos, K., Christie, J., Mandzuk, S., & Vukelich, C. (2005). Learning words: group time as a vocabulary development opportunity. *Journal of Research in Childhood Education, 19*, 333–345.

Hargrave, A. C., & Sénéchal, M. (2000). A Book Reading Intervention with Preschool Children who have Limited Vocabularies: The Benefits of Regular Reading and Dialogic Reading. *Early Childhood Research Quarterly, 15*(1), 75–90.

Hiebert, E. H., & Fisher, C. W. (2007). Critical Word Factor in texts for beginning readers. *The Journal of Educational Research, 101*(1), 3–11.

Hiebert, E.H., Scott, J.A., Castaneda, R., Spichtig, A. (2019). An Analysis of the Features of Words that Influence Vocabulary Difficulty. *Education Sciences, 9(*1), 8-32.

Hindman, A.H., Connor, C.M., Jewkes, A.M., Morrison, F.J. (2008). Untangling the effects of shared book reading: Multiple factors and their associations with preschool literacy outcomes. *Early Childhood Research Quarterly, 23*(3), 330-350.

Hindman, A. H., Skibbe, L. E., & Foster, T. D. (2014). Exploring the variety of parental talk during shared book reading and its contributions to preschool language and literacy: Evidence from the Early Childhood Longitudinal Study-Birth Cohort. *Reading and Writing: An Interdisciplinary Journal, 27*(2), 287–313.

Hoff, E. (2003a). Causes and consequences of SES-related differences in parent-to-child speech. In M. H. Bornstein, & R. H. Bradley (Eds.), *Socioeconomic status, parenting, and child development* (pp. 147–160). Mahwah, NJ: Erlbaum.

Hoff, E. (2003b). The specificity of environmental influence: Socioeconomic status affects early vocabulary development via maternal speech. *Child Development, 74*, 1368–1378.

Hoffman, J. V., Wilson, M. B., Martinez, R. A., & Sailors, M. (2011). Content analysis: The past, present, and future. In N. K. Duke & M. H. Mallette (Eds.), *Literacy Research Methodologies* (2nd ed., pp. 28–49). New York, NY: Guilford Press.

Huebner, C.E. (2000a). Promoting Toddlers' Language Development through Community-Based Intervention. *Journal of Applied Developmental Psychology, 21*(5), 513-535.

Huebner, C. E., & Meltzoff, A. N. (2005). Intervention to change parent-child reading style: A comparison of instructional methods. *Journal of Applied Developmental Psychology, 26*(3), 296–313.

Huebner, C. E., & Payne, K. (2010). Home support for emergent literacy: Follow-up of a community-based implementation of dialogic reading. *Journal of Applied Developmental Psychology, 31*(3), 195–201.

Ihmeideh, F. M. (2014). The effect of electronic books on enhancing emergent literacy skills of pre-school children. *Computers & Education, 79,* 40–48.

Ito, M. (2009). *Engineering Play: A cultural history of children's software*. Cambridge: MA: The MIT Press.

Krippendorff, K. (2013). *Content analysis: An introduction to its methodology*. Thousand Oaks, CA: Sage.

Korat, O., & Shamir, A. (2004). Are electronic books for young children appropriate to support literacy development? A comparison across languages. *Journal of Computer Assisted Learning, 20*, 257–268.

Korat, O., & Shamir, A. (2008). The educational electronic book as a tool for supporting children's emergent literacy in low versus middle SES groups. *Computers & Education, 50*(1), 110–124.

Korat, O. & Or, T. (2010). How New Technology Influences Parent-Child Interaction: The Case of E-book Reading. *First Language, 30*(2), 139-154.

Korat, O., Shamir, A., & Heibal, S. (2013). Expanding the boundaries of shared book reading: E-books and printed books in parent-child reading as support for children's language. *First Language, 33*(5), 504-523.

Krcmar, M. & Cingel, D.P. (2014). Parent-Child Joint Reading in Traditional and Electronic Formats. *Media Psychology, 3*, 262-281.

Kucirkova, N. (2019). Children's Reading with Digital Books: Past Moving Quickly to the Future. *Child Development Perspectives, 13*(4), 208-214.

Landry, S.H., Smith, K.E., Swank, P.R., Zucker, T., Crawford, A.D., Solari, E.F. (2012). The Effects of a Responsive Parenting Intervention on Parent-Child Interactions During Shared Book Reading. *Developmental Psychology, 48*(4), 969-986.

Lareau, A. (1989). *Home advantage: Social class and parental intervention in elementary education*. New York: Palmer Press.

Lauricella, A.R., Barr, R., Calvert, S.L. (2016). Toddler learning from video: Effect of matched pedagogical cues. *Infant Behavior and Development, 45*, 22-30.

Lauricella, A. R., Blackwell, C. K., & Wartella, E. (2017). The "new" technology environment: The role of content and context on learning and development from mobile media. In R. Barr & D. N. Linebarger (Eds.), *Media exposure during infancy and early childhood: The effects of content and context on learning and development* (pp. 1–23). Springer International Publishing AG.

Levine, A. (2006). *Educating School Teachers*. Princeton, NJ: The Education Schools Project.

Littleton, K.; Wood, C. and Chera, P. (2006). Interactions with talking books: Phonological awareness affects boys' use of talking books. *Journal of Computer Assisted Learning, 22*(5), 382–390.

Lonigan, C. J. (2007). Vocabulary development and the development of phonological awareness skills in preschool children. In R. K. Wagner, A. E. Muse, & K. R. Tannenbaum (Eds.), *Vocabulary acquisition: Implications for reading comprehension* (pp. 15–31). Guilford Press.

Lonigan, C.J., Anthony, J.L., Bloomfield, B.G., & Dyer, S.M. (1999). Effects of Two Shared-Reading Interventions on Emergent Literacy Skills of At-Risk Preschoolers. *Journal of Early Intervention, 22*(4), 306-322.

Lonigan, C. J., & Shanahan, T. (2009). *Developing early literacy: report of the national early literacy panel. Executive summary. A scientific synthesis of early literacy development and implications for intervention*. Washington, DC: National Institute for Literacy.

Lugo-Neris, M. J., Jackson, C. W., & Goldstein, H. (2010). Facilitating vocabulary acquisition of young English language learners. *Language, Speech, and Hearing Services in Schools, 41*(3), 314–327.

MacWhinney, B. (2000). *The CHILDES project* (3rd Ed). Mahwah, NJ: Erlbaum.

Marulis, L.M. & Neuman, S.B. (2013). How Vocabulary Interventions Affect Young Children at Risk: A Meta-Analytic Review. *Journal of Research on Educational Effectiveness, 6*(3), 223-262.

Massaro, D. W. (2016). Multiple influences in vocabulary acquisition: parental input dominates. In *Proceedings of the 17th Annual Conference of the International Speech Communication Association (Interspeech 2016)*, 878–882.

McDonough, C., Song, L., Hirsh-Pasek, K., Golinkoff, R. M., & Lannon, R. (2011). An image is worth a thousand words: Why nouns tend to dominate verbs in early word learning. *Developmental Science, 14*(2), 181-189.

Mercer, N., Dawes, L., Wegerif, R., & Sams, C. (2004). Reasoning as a scientist: Ways of helping children to use language to learn science. *British Educational Research Journal, 30*(3), 359–377.

Mesmer, H.A. (2016). Text Matters: Exploring the lexical reservoirs of books in preschool rooms. *Early Childhood Research Quarterly, 34*(1), 67-77.

Miedel, W. T., & Reynolds, A. J. (1999). Parent involvement in early intervention for disadvantaged children: Does it matter? *Journal of School Psychology, 37*(4), 379–402.

Mol, S. E., Bus, A. G., De Jong, M. T., & Smeets, D. J. H. (2008). Added value of dialogic parent-child book readings: A meta-analysis. *Early Education and Development, 19*, 7-26.

Mol, S. E., Bus, A. G., & de Jong, M. T. (2009). Interactive book reading in early education: a tool to stimulate print knowledge as well as oral language. *Review of Educational Research, 79*(2), 979–1007.

Munzer, T.G., Miller, A.L., Weeks, H.M., Kaciroti, N., Radesky, J. (2019). Differences in Parent-Toddler Interactions with Electronic Versus Print Books. *Pediatrics, 143*(3).

Nagy, W. E., Anderson, R. C., & Herman, P. A. (1987). Learning word meanings from context during normal reading. *American Educational Research Journal, 24*(2), 237–270.

Nagy, W.E. & Hiebert, E.H. (2011). Toward a theory of word selection. In Kamil, M.L., Pearson, P.D., Moje, E.B., & Afflerbach, P.P. (Eds.), *Handbook of Reading Research* (pp. 388-404). New York, NY: Longman.

Naigles, L.R. & Hoff-Ginsberg, E. (1998). Why are some verbs learned before other verbs? Effects of input frequency and structure on children's early verb use. *Journal of Child Language, 25*(1), 95-120.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards for English language arts and literacy in history/social studies, science, and technical subjects*. Washington, DC: Authors.

Neugebauer, S. R., Gámez, P. B., Coyne, M. D., Cólon, I. T., McCoach, D. B., & Ware, S. (2017). Promoting word consciousness to close the vocabulary gap in young word learners. *The Elementary School Journal, 118*(1), 28–54.

Neuendorf, K. A. (2002). *The Content Analysis Guidebook*. Thousand Oaks, CA: Sage Publications.

Neuman, S.B. (1995). *Literacy in the television age: The myth of the TV effect* (2nd ed.). Norwood, NJ: Ablex.

Neuman, S. B. (1996). Children engaging in storybook reading: the influence of access to print resources, opportunity, and parent interactions. *Early Childhood Research Quarterly, 11*, 495–513.

Neuman, S. B. (1997). Television as a learning environment: A theory of synergy. In J. Flood, S. Brice Heath, & D. Lapp (Eds.), *Handbook of research on teaching literacy through the communicative and visual arts* (pp. 15–30). New York, NY: Simon & Shuster.

Neuman, S. B. (2009). The case for multimedia presentations in learning. In A. Bus & S.B. Neuman (Eds.), *Multimedia and literacy development: improving achievement for young learners* (pp. 44–56). New York, NY: Taylor & Francis.

Neuman, S.B. & Celano, D. (2001) Access to Print in Low-Income and Middle-Income Communities: An Ecological Study of Four Neighborhoods. *Reading Research Quarterly, 36*(1), 8-26.

Neuman, S.B. & Moland, N. (2016). Book Deserts: The Consequences of Income Segregation on Children's Access to Print. *Urban Education, 54*(1), 126-147.

Neuman, S.B., Wong, K. M., Flynn, R., & Kaefer, T. (2019). Learning vocabulary from educational media: The role of pedagogical supports for low-income preschoolers. *Journal of Educational Psychology, 111*(1), 32–44.

Neumann, M.M. (2020). The Impact of Tablets and Apps on Language Development. *Childhood Education, 96*(6), 70-74.

Ouellette, G., & Beers, A. (2010). A not-so-simple view of reading: How oral vocabulary and visual-word recognition complicate the story. *Reading and Writing, 23*(2), 189–208.

Paivio, A. (1986). *Mental representations: A dual coding approach*. Oxford, UK: Oxford University Press.

Pan, B. A., Rowe, M. L., Singer, J. D., & Snow, C. E. (2005). Maternal correlates of growth in toddler vocabulary production in low-income families. *Child Development, 76*(4), 763–782.

Parish-Morris, J., Mahajan, N., Hirsh-Pasek, K., Golinkoff, R. M., & Collins, M. F. (2013). Once upon a time: Parent–child dialogue and storybook reading in the electronic era. *Mind, Brain, and Education, 7*(3), 200–211.

Patte, M.M. (2011). Examining Preservice Teacher Knowledge about Competencies in Establishing Family-School Partnerships. The School Community Journal, 21(2), 143-159.

Pellegrini, A. D., Perlmutter, J. C., Galda, L., & Brody, G. H. (1990). Joint reading between Black Head Start children and their mothers. *Child Development, 61*(2), 443–453.

Perfetti, C., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading, 18*(1), 22–37.

Publishers Weekly. (June 21, 2021). www.publisher-weekly.com/pw/by-topic/childrens/childrens-industry-news/article/52632-the-kids-books-are-alright-says-the-aap-s-monthly-statshot.html.

RAND Reading Study Group. (2002). Reading for understanding: Toward and R&D program in reading comprehension. Retrieved from http://www.rand.org/pubs/monograph_reports/MR1465.html.

Restrepo, M. A., Morgan, G. P., & Thompson, M. S. (2013). The efficacy of a vocabulary intervention for dual-language learners with language impairment. *Journal of Speech, Language, and Hearing Research, 56*(2), 748–765.

Rex, L. A., & Schiller, L. (2009). *Using discourse analysis to improve classroom interaction*. Routledge.

Ricketts, J., Nation, K., & Bishop, D. V. M. (2007). Vocabulary is important for some, but not all reading skills. *Scientific Studies of Reading, 11*(3), 235–257.

Rideout, V. & Robb, M.B. (2020). *The Common Sense Census: Media use by kids age zero to eight, 2020*. San Francisco, CA: Common Sense Media.

Roberts, T., & Neal, H. (2004). Relationships among preschool English language learner's oral proficiency in English, instructional experience, and literacy development. *Contemporary Educational Psychology, 29*(3), 283–311.

Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development. *Child Development, 83*(5), 1762–1774.

Rowe, M.L. & Snow, C.E. (2020). Analyzing input quality along three dimensions: interactive, linguistic, and conceptual. *Journal of Child Language, 47*(1) 5-21.

Sargeant, B. (2015). What is an ebook? What is a Book App? And Why Should We Care? An Analysis of Contemporary Digital Picture Books. *Children's Literature in Education, 48*(4), 454-466.

Segal-Drori, O., Korat, O., Shamir, A., & Klein, P. S. (2010). Reading electronic and printed books with and without adult instruction: Effects on emergent reading. *Reading and Writing: An Interdisciplinary Journal, 23*(8), 913–930.

Segers, E., Nooijen, M., & de Moor, J. (2006). Computer vocabulary training in kindergarten children with special needs. *International Journal of Rehabilitation Research, 29*(4), 343-345.

Sénéchal, M. (1997). The differential effect of storybook reading on preschoolers' acquisition of expressive and receptive vocabulary. *Journal of Child Language, 24*, 123–138.

Sénéchal, M. (2006). Testing the Home Literacy Model: Parent Involvement in Kindergarten is Differentially Related to Grade 4 Reading Comprehension, Fluency, Spelling, and Reading for Pleasure. *Scientific Studies of Reading, 10*(1), 59–87.

Sénéchal, M., & Cornell, E. H. (1993). Vocabulary acquisition through shared reading experiences. *Reading Research Quarterly, 28*, 360–374.

Sénéchal, M., Cornell, E. H., & Broda, L. (1995). Recall of picture books by 3-year-old children: testing and repetition effects in joint reading activities. *Educational Psychology, 80*(4), 537–542.

Sénéchal, M., Thomas, E., & Monker, J. (1995). Individual differences in 4-year-old children's acquisition of vocabulary during storybook reading. *Journal of Education Psychology, 87*(2), 218–229.

Sénéchal, M., LeFevre, J.-A., Thomas, E. M., & Daley, K. E. (1998). Differential effects of home literacy experiences on the development of oral and written language. *Reading Research Quarterly, 33*(1), 96–116.

Senechal, M., Ouellette, G., & Rodney, D. (2006). The misunderstood giant: On the predictive role of early vocabulary to future reading. In S. B. Neuman & D. K. Dickinson (Eds.), *Handbook of early literacy research* (2nd ed., pp. 173–182). Guilford Press.

Shamir, A., & Korat, O. (2007). Developing an Educational E-Book for Fostering Kindergarten Children's Emergent Literacy. *Computers in the Schools, 24*(2), 125-143.

Shanahan, T., Callison, K., Carriere, C., Duke, N. K., Pearson, P. D., Schatschneider, C., & Torgesen, J. (2010). *Improving reading comprehension in kindergarten through 3rd grade: A practice guide* (NCEE 2010-4038). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from https://ies.ed.gov/ncee/wwc/PracticeGuide/14

Silverman, R., & Hines, S. (2009). The effects of multimedia-enhanced instruction on the vocabulary of English-language learners and non-English-language learners in pre-kindergarten through second grade. *Journal of Educational Psychology, 101*(2), 305.

Smeets, D.J.H, & Bus, A. (2014). The interactive animated e-book as a word learning device for kindergartners. *Applied Psycholinguistics, 36*(4), 1-22.

Snow, C. E., & Beals, D. E. (2006). Mealtime talk that supports literacy development. In R. W. Larson, A. R. Wiley, & K. R. Branscomb (Eds.), *Family mealtime as a context of development and socialization* (pp. 51–66). Jossey-Bass.

Sorsby, A. J., & Martlew, M. (1991). Representational demands in mothers' talk to preschool children in two contexts: picture book reading and a modeling task. *Journal of Child Language, 18*, 373–393.

Stone, S., & Twardosz, S. (2001). Children's books in child care classrooms: quality, accessibility, and reasons for teachers' choices. *Journal of Research in Childhood Education, 16*(1), 53–69.

Storch, S. A., & Whitehurst, G. J. (2002). Oral language and code-related precursors to reading: Evidence from a longitudinal structural model. *Developmental Psychology, 38*, 934–947.

Strouse, G.A., O'Doherty, K., & Troseth, G.L. (2013). Effective Co-viewing: Preschoolers' Learning from Video After a Dialogic Questioning Intervention. *Developmental Psychology, 49*(12), 2268-82.

Strouse, G. A., & Troseth, G. L. (2014). Supporting toddlers' transfer of word learning from video. *Cognitive Development, 30,* 47–64.

Takacs, Z. K., & Bus, A. G. (2018). How pictures in picture storybooks support young children's story comprehension: An eye-tracking experiment. *Journal of Experimental Child Psychology, 174,* 1-12.

Takanishi, R., & Le Menestrel, S. (2017). *Promoting the educational success of children and youth learning English: Promising futures.* National Academies Press.

Taxel, J. (2011). The economics of children's book publishing in the 21st century. In S.A. Wolf, K. Coats, P. Enciso, & C.A. Jenkins (Eds.), *Handbook of research on children's and young adult literature* (pp. 479-494). New York, NY: Routledge.

Teale, W.H. (1986). Home background and young children's literacy development. In W. H. Teale & E. Sulzby (Eds.), *Emergent Literacy* (pp. 173-206). Norwood, NJ: Ablex.

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*, 45-58.

van Kleek, A., Gillam, R., Hamilton, L., & McGrath, C. (1997). The relationship between middle-class parents' book-sharing discussion and their preschoolers' abstract language development. *Journal of Speech, Language, and Hearing Research, 40*(6), 1261–1271.

van Kleeck, A. (2003). Research on book sharing: another critical look. In K. van Kleeck, S. Stahl, & E. Bauer (Eds.), *On reading books to children* (pp. 271–320). Mahwah, NJ: Erlbaum.

van Kleeck, A., Vander Woude, J., & Hammett, L. (2006). Fostering literal and inferential language skills in head start preschoolers with language impairment using scripted book-sharing discussions. *American Journal of Speech-Language Pathology, 15*(1), 85–95.

Verhallen, M. J., Bus, A. G., & de Jong, M. T. (2006). The promise of multimedia stories for kindergarten children at risk. *Journal of Educational Psychology, 98*(2), 410.

Vygotsky, L. S. (1978). *Mind in society* (M. Cole, V. John-Steiner, S. Schribner, & E. Souberman, Trans.). Harvard University Press.

Vygotsky, L. S. (1986). *Thought and language* (A. Kozulin, Trans.; Translation newly rev. and edited). MIT Press.

Wasik, B. A., Hindman, A. H., & Snell, E. K. (2016). Book reading and vocabulary development: A systematic review. *Early Childhood Research Quarterly, 37,* 39–57.

Weizman, Z.O. & Snow, C.E. (2001). Lexical Input as Related to Children's Vocabulary Acquisition: Effects of Sophisticated Exposure and Support for Meaning. *Developmental Psychology, 37*(2), 265-279.

Wellman, H. M., & Woolley, J. D. (1990). From simple desires to ordinary beliefs: the early development of everyday psychology. *Cognition, 35*(3), 245–275.

Whitehurst, G. J., Falco, F. L., Lonigan, C. J., Fischel, J. E., DeBaryshe, B. D., Valdez-Menchaca, M. C., & Caulfield, M. (1988). Accelerating language development through picture book reading. *Developmental Psychology*, *24*, 552–559.

Wright, T.S. (2019). Reading to Learn from the Start: The Power of Interactive Read Alouds. American Educator, 42(4), 4.

Wright, T. S., & Gotwals, A. W. (2017). Supporting kindergartners' science talk in the context of an integrated science and disciplinary literacy curriculum. The Elementary School Journal, 117(3), 513–537.

Zevenbergen, A. A., & Whitehurst, G. J. (2003). Dialogic reading: a shared picture book reading. In A. Van Kleeck, S. A. Stahl, & E. Bauer (Eds.), *On reading books to children*. Mahwah, NJ: Erlbaum.

Zimmerman, F. J., Gilkerson, J., Richards, J. A., Christakis, D. A., Xu, D., Gray, S., & Yapanel, U. (2009). Teaching by listening: The importance of adult–child conversations to language development. *Pediatrics, 124*, 342–349.

Zipke, M. (2013). Building an e-book library: resources for finding the best apps. *The Reading Teacher, 67*(5), 375–383.

Zucker, T.A., Moody, A.K., McKenna, M.C. (2009). The Effects of Electronic Books on Pre-Kindergarten to Grade 5 Students' Literacy and Language Outcomes: A Research Synthesis. *Journal of Educational Computing Research, 40*(1), 47-87.