

UC Irvine

UC Irvine Previously Published Works

Title

Self-regulation and comprehension in shared reading: The moderating effects of verbal interactions and E-book discussion prompts.

Permalink

<https://escholarship.org/uc/item/1bj8q0ts>

Journal

Child Development, 95(6)

Authors

Yang, Dandan

Ge, Yan

Sun, Yiwen

et al.

Publication Date




2024

DOI

10.1111/cdev.14128

Peer reviewed

Self-regulation and comprehension in shared reading: The moderating effects of verbal interactions and E-book discussion prompts

Dandan Yang^{1,2}  | Yan Ge³ | Yiwen Sun⁴ | Penelope Collins¹  | Susanne M. Jaeggi⁵ | Ying Xu⁶  | Zhiling Meng Shea⁷ | Mark Warschauer¹

¹University of California, Irvine, Irvine, California, USA

²University of California, Los Angeles, Los Angeles, California, USA

³King's College London, London, UK

⁴Columbia University Teachers College, New York, New York, USA

⁵Northeastern University, Boston, Massachusetts, USA

⁶University of Michigan, Ann Arbor, Michigan, USA

⁷University of Virginia, Charlottesville, Virginia, USA

Correspondence

Dandan Yang, School of Education, University of California, Irvine, 401 E. Peltason Drive, Suite 3200, Irvine, CA 92617, USA.

Email: dandany1@uci.edu

Funding information

University of California Office of the President; International Research Foundation for English Language Education; Duolingo

Abstract

The study examined how children's self-regulation skills measured by the strengths and weaknesses of ADHD symptoms and normal behavior rating are associated with story comprehension and how verbal engagement and e-book discussion prompts moderate this relation. Children aged 3–7 ($N=111$, 50% female, Chinese as first language) read an interactive Chinese–English bilingual story e-book with or without discussion prompts twice with their parents (2020–2021). Results demonstrated that the lower children's self-regulation skills, the more they struggled with story comprehension. Critically, our data suggest that embedding e-book discussion prompts and more verbalization in English can mitigate this negative association for children with inattention/hyperactivity. These findings have critical implications for future e-book design, interventions, and home reading practice for children with inattention/hyperactivity and those at risk for attention deficit/hyperactivity disorder.

Shared reading of picture storybooks between parents and young children who have not yet developed decoding and text reading abilities is a crucial source of high-quality language and literacy input (Bus et al., 2020) prior to formal literacy instruction. During this early literacy practice, children's ability to comprehend stories is a significant indicator of their readiness for school (Dickinson & Porche, 2011) and their language and literacy development (Swanson et al., 2012). In contrast to reading comprehension which requires word decoding

skills (e.g., Kim, 2016), story comprehension abilities usually emerge from understanding oral language in advance of children learning to read (Skarakis-Doyle & Dempsey, 2008). Moreover, research suggests that story comprehension skills at this age can predict reading comprehension (Skarakis-Doyle & Dempsey, 2008), academic achievement (Cain & Oakhill, 2011), and writing performance (Nelson et al., 2017) in later grades.

Successful story comprehension goes beyond merely understanding individual vocabulary and phrases and

Abbreviations: ADHD, attention deficit/hyperactivity disorder; ANOVA, analysis of variance; CLAN, Computerized Language ANalysis program; CROWD, completion, recall questions, open-ended questions, Wh-questions, distancing questions; DIET, Direct and Indirect Effect Model of Text; DR, dialogic reading; EFL, English as a Foreign Language; PEER, prompt, evaluate, expand, repeat; SWAN, Strengths and weaknesses of ADHD symptoms and normal behavior.

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDerivs](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2024 The Author(s). *Child Development* published by Wiley Periodicals LLC on behalf of Society for Research in Child Development.

requires the coordination of a series of foundational cognitive skills to construct a suitable mental representation of the story events that lead to successful comprehension (Kim, 2016). Among these skills, self-regulation, including attentional skills and inhibitory control skills (McClelland et al., 2007), is a critical cognitive capacity that enables a child to manage their thoughts, emotions, and behaviors to achieve optimal comprehension outcomes (Kim, 2016; Kim & Phillips, 2014). Attention and inhibitory control, in particular, enable children to focus on the relevant focal stimuli and ignore irrelevant information (e.g., Kim, 2016), thereby establishing coherence at both the local levels (respective propositions) and global levels (across propositions) (Van Dijk & Kintsch, 1983).

Children with weak self-regulatory skills are more likely to struggle with story comprehension, leading to lower reading comprehension performance, academic difficulties, and social challenges in adolescence and adulthood (Moffitt et al., 2011; Skarakis-Doyle & Dempsey, 2008). It is concerning that a nationally representative sample in the United States discovered that approximately 23% of children aged 3–5 exhibit these weaknesses in self-regulation (Claussen et al., 2021). Therefore, there is a pressing need for well-designed interventions that can help prevent significant delays in reading comprehension and academic achievement in later grades, in order to support and promote the academic success of these children.

With the prevalence of mobile devices and storybook apps, parents reading stories with their children on tablets or cell phones have become a common home literacy activity. Research has shown that parent–child shared reading using well-designed multimedia e-books can have numerous benefits, including enhancing children's sustained attention (Richter & Courage, 2017), promoting parents' ability to scaffold children's word learning (Ronimus et al., 2019), increasing parent–child interactions and engagement with storybooks (Troseth et al., 2020) and leading to better story comprehension outcomes (Altun, 2022; Zevenbergen & Whitehurst, 2003). Shared reading practice, with its emphasis on joint engagement and parent–child interaction, may be especially advantageous for children with weak self-regulatory skills, as these interactions can assist children in regulating their attention and allowing them to focus on comprehension tasks (e.g., Noble et al., 2020). Therefore, promoting this type of shared reading activity may be a promising strategy for supporting the academic success of children who are at risk for reading difficulties.

Despite the potential benefits of shared reading using e-books, little research has examined the role of e-book features, such as discussion prompts, in supporting story comprehension by moderating the negative impact of weak self-regulations on comprehension. Additionally, few studies have focused on developing interventions and technologies that facilitate dialogic reading (DR)

opportunities for this group of children. To this end, this paper aims to fill these gaps by examining the extent to which children's attentional and inhibitory control skills predict their story comprehension during the shared reading of an interactive story e-book. Furthermore, we seek to evaluate the effectiveness of the discussion prompts feature and verbal engagement in moderating the relation between self-regulation and story comprehension.

The following three research questions guided the study design and analysis:

1. To what extent do children's self-regulation skills predict children's story comprehension during parent–child shared reading?
2. To what extent do e-book discussion prompts moderate the effects of self-regulation skills on story comprehension?
3. To what extent does children's verbal engagement moderate the effects of self-regulation skills on story comprehension?

LITERATURE REVIEW

Story comprehension and self-regulation

Both reading and listening comprehension require the construction of coherent mental representations of texts, requiring a variety of cognitive and language skills operating at different levels. According to the Direct and Indirect Effect Model of Text (DIET, see Kim, 2016), the comprehension process involves three levels of processing: “representation of surface code (the linguistic input of texts), text base representation (encoding meanings from texts), and constructing a mental representation (integrate meanings across propositions)” (p. 105). For narrative texts, the mental representation is centered on a goal, along with the causal and temporal connections that it encompasses (Skarakis-Doyle & Dempsey, 2008). Therefore, to comprehend a story accurately, children must establish the coherence of sentences and sequential events in order to obtain an appropriate understanding of the narrative.

Self-regulatory skills, including various executive functions such as attention (Kim, 2016) and inhibitory control (Kim & Phillips, 2014), are particularly foundational for successful story comprehension. As a prerequisite for any learning task based on information processing theories (Verhoeven et al., 2011), attentional control enables children to process upcoming input while holding information during story comprehension (Kim, 2016). While individuals must draw inferences to understand a story, their attentional resources to do so are limited. Extensive research has shown that attention is associated with preschoolers' literacy skills, such as vocabulary (Strasser & Río, 2013) and grammatical knowledge (Kim, 2016), both of which are essential linguistic skills

for story comprehension and later academic achievement. Therefore, children with weaker attentional skills can experience even more difficulties maintaining and retrieving information from input and constructing connections between story events (Kim, 2016).

Inhibitory control, another aspect of self-regulation, which involves suppressing a strong response in favor of a more appropriate one, is an essential cognitive skill required for successful story comprehension (Kim & Phillips, 2014). Children's weak inhibitory control is often reflected by their impulsive and hyperactive behaviors, such as reacting before understanding a task or responding prematurely without adequate information (Schachar & Logan, 1990). Inhibitory control has been found to significantly correlate with preschoolers' emergent literacy and vocabulary development (McClelland et al., 2007) and academic achievement such as reading (Kim, 2016). During the process of comprehending narrative texts, inhibitory control allows children to prevent irrelevant and distracting information from entering their working memory. This, in turn, can facilitate their ability to concentrate on essential and relevant information while also preventing their attention from being diverted back to information that is no longer relevant (Kim & Phillips, 2014). With good inhibitory control skills, children can devote more cognitive resources to processing discourse by directing their focus toward less noticeable but more critical elements and suppressing their attention toward interesting but unimportant details.

Taken together, self-regulatory skills, including attention and inhibitory control, are crucial executive functions that aid children in comprehending narrative texts and developing fundamental language and literacy skills. Children with deficits in these skills, such as those diagnosed with attention deficit/hyperactivity disorder (ADHD), can struggle with comprehending stories and acquiring literacy skills (e.g., Miller et al., 2013), which can negatively impact their mathematical ability, language development, and overall academic performance (Papaeliou et al., 2012). Despite the critical role of these self-regulatory cognitive skills, few studies have examined interventions, including technology-based ones, to help children with weak attention and inhibitory control improve their story comprehension outcomes. Furthermore, more research is needed to explore interventions that can enhance comprehension performance and support the language and academic development of these children.

Dialogic reading

DR is an evidence-based approach that promotes children's active participation in shared reading, first proposed by Whitehurst et al. (1988). Unlike traditional styles of shared reading, where caregivers read and

children passively listen, DR encourages children to become storytellers with the support of adults' questions related to the story, thus demonstrating self-agency. Researchers have developed prompting guidance represented by the acronyms PEER (prompt, evaluate, expand, repeat; see Whitehurst et al., 1994) and CROWD (completion, recall, open-ended questions, wh-questions, distancing; see Zevenbergen & Whitehurst, 2003) to help adults learn about DR strategies. Following these strategies during shared reading, caregivers can promote social interactions with their children, sustain their attention, and enhance their verbal engagement with the text (Simsek & Erdogan, 2015).

Empirical evidence suggests that DR has the strong potential to promote a wide range of language and literacy skills, including phonological awareness (Chow et al., 2010), receptive vocabulary (Simsek & Erdogan, 2015), expressive vocabulary (Mol et al., 2008; Rahn et al., 2016), word reading (Chow et al., 2010; Pillinger & Wood, 2014), character recognition (Chow et al., 2010), and comprehension (Dore et al., 2018). Specifically, the effect of DR in promoting vocabulary is particularly significant for younger children and those without risk of language impairments (Mol et al., 2008). Hoffman and Paciga (2013) emphasize the importance of parent-child shared reading in supporting children's language and literacy development, particularly during the e-book reading experience. However, despite the positive findings of DR among monolingual English-speaking children, little research has been conducted to explore its effectiveness in improving the language and literacy outcomes of linguistically diverse children, such as English as a Foreign Language (EFL) children. In fact, the current literature revealed mixed findings about the cognitive abilities of bilingual children. While highly balanced bilingual children were reported to possess higher cognitive flexibility, such as attentional control (e.g., Adesope et al., 2010), such advantages may not exist among partial bilinguals who do not speak the two languages with balanced proficiencies (e.g., Haft et al., 2019). Therefore, it remains unclear whether partial bilinguals could benefit from DR of bilingual e-books in their self-regulatory cognitive abilities.

Apart from the benefits for language and literacy ability skills, DR is also found to have a positive influence on many cognitive, motivational, and developmental outcomes, especially for younger children, including enhanced engagement (Richter & Courage, 2017), increased enjoyment (Pillinger & Wood, 2014), sustained attention (Hutton et al., 2017), affect control (Niu et al., 2021), and improved communication between children and caregivers (Ganotice et al., 2016). Studies have shown that DR as an intervention method can help to improve children's ability to pay attention for a long time to a given stimulus (Twait et al., 2019). In other words, children's interaction with adults during shared reading activities has the potential to help them develop and use their language skills

and allocate more attentional resources to comprehend texts.

Despite the influence of DR on children's cognitive and language skills, few studies have explored the impact of DR on improving the comprehension performance of children with weak self-regulation skills. Some pioneering studies found that DR can improve preschoolers' resilience (Niu et al., 2021), language skills, and listening comprehension (Dong et al., 2022). However, these findings are limited to observations of children diagnosed with ADHD. It is yet to be determined whether the benefits of DR in sustaining attention and improving comprehension outcomes extend to typically developing children or those at risk of ADHD.

Story e-books and discussion prompts

The increasing prevalence of tablets and literacy apps has prompted researchers to investigate the efficacy of digital books in promoting children's learning (Bus et al., 2020). However, the literature provides mixed findings regarding the effectiveness of multimedia features, including audio, image, and video inputs, embedded in e-book design. Some studies have suggested that digital storybooks with multimedia features enhance children's engagement, motivation, and attention compared to traditional printed books (e.g., Richter & Courage, 2017; Troseth et al., 2020). Conversely, other studies have reported that some technology-enhanced e-book features may hinder learning (e.g., Lim et al., 2021).

Evidence has shown that multimedia features that do not correspond to the narrative may not benefit but rather diminish the learning potential of digital storybooks, especially for children who have problems with staying focused or verbal processing (Takacs et al., 2015). For example, multimedia elements such as games and dictionaries have the potential to interfere with the storyline and children's processing of the narrative (Bus et al., 2015, 2020). One potential reason is that visualizations that are incongruent with the storyline can be distracting and require multitasking which is particularly difficult for young children with immature executive functions, especially those with identified attention deficits (Bus et al., 2015). From the perspective of information processing, when children are engaged in more than one task simultaneously, such as reading a story while interacting with hotspots (clickable animations on screens that trigger animations or sounds), they might be required to continuously switch between different tasks, which can have consequences for story comprehension and result in cognitive overload (Paas & Sweller, 2014).

By contrast, the multimedia components aligning with the story plots have been found to enhance

children's attention and engagement (Li et al., 2023; Richter & Courage, 2017; Sun et al., 2022; Takacs & Bus, 2016; Troseth et al., 2020; Yow & Priyashri, 2019), improve vocabulary (Furenes et al., 2021), and promote children's learning outcomes in story comprehension (Altun, 2022; Sun et al., 2019). The additional visual and auditory information embedded in the e-books can provide scaffolding for children to understand the narrative texts in bilingual settings (Sun et al., 2022). Also, the enhanced electronic features of e-books are found to direct children's attention to the text in both their dominant and nondominant language (Yow & Priyashri, 2019). The positive effects of multimedia features on story comprehension have been larger for disadvantaged children compared to the non-disadvantaged children (Takacs et al., 2015). For example, a remedial reading intervention with iPads was found to significantly improve reading comprehension and vocabulary for secondary students with learning disabilities (Retter et al., 2013). In another study (Ertem, 2010), struggling fourth graders (aged 9–11) who read a story using e-books with animations significantly outperformed the control groups who read the e-book without animations in story comprehension. These findings suggest that adding appropriate features to digital e-books could help to improve the performance of struggling readers.

Among these positive multimedia components, those that can promote children's verbal engagement in story reading are almost consistently found to have a positive influence on enhancing children's story comprehension (Takacs et al., 2015; Troseth et al., 2020). For example, on-screen dialogic questioners embedded in e-books are found to be a highly effective design that has comparable effectiveness as parent-led questions in scaffolding children aged between 4 and 7 to understand the causal relations and thematic importance of story events (Smeets & Bus, 2014), helping children aged from 3 to 5 stay focused (Richter & Courage, 2017) and enhancing their story comprehension outcomes (Troseth et al., 2020). Potential concerns may exist that the discussion prompts may interrupt the reading flow, but experimental studies (e.g., Yang et al., 2022) found that overall, embedding e-book discussion prompts positively contribute to children's better performance in story comprehension and prompted retelling in English as foreign language settings. Particularly, when reading e-books embedded with discussion prompts followed by individualized feedback, parents tended to follow and practice the PEER reading flow even without intentional training. These studies on e-book discussion prompts shed light on the potential benefits of this design feature to enhance story comprehension, but none of them investigated whether and how the effectiveness of this feature may differ in children with diverse self-regulatory skills, which is the purpose of the current study.

METHOD

Participants

To address our research questions, we conducted a secondary analysis using data from a randomized controlled trial (Yang et al., 2022), which was aimed to examine the impact of e-book discussion prompts on children's learning outcomes during parent-child shared reading. At the beginning of the study, 130 families were recruited using a snowball sampling method through social media platforms and provided informed consent. The participants were children aged 3–7 who spoke Chinese as their first language and their parents from China. Although a small number of participants reside in the Guangdong (Cantonese language) area and speak both Cantonese and Mandarin Chinese in daily conversations, all of them willingly chose to use Mandarin Chinese during the parent-child shared reading sessions.

The analysis sample included 111 families who completed the whole intervention with pre- and post-test scores, and two recorded reading sessions. The study was conducted remotely during the COVID-19 pandemic (10/2020–04/2021) and the drop-out happened due to various reasons such as the internet issues, participant's being sick, or technical and adaptability issues with the e-book website. Paired *t*-tests indicated that there are no statistically significant differences in parents' education level, their monthly income and children's gender between the participants who dropped out and those who did not. Ethical clearance was obtained from the institutional review board at the first author's university. Demographic information for the participants is presented in Table 1.

The e-book story and discussion prompts

The interactive bilingual e-book used in this study titled *The Story of an Orange Oakleaf* tells the story of an oak-leaf butterfly that initially feels inferior due to its dry-leaf-like wings, which it believes are less beautiful than those of other butterflies. However, as the story unfolds, the butterfly comes to appreciate its unique appearance as it enables it to avoid being spotted by an evil bird and ultimately saves its butterfly friends. The e-book is a web-based application designed for touchscreen tablets such as iPads and is embedded with various multimedia interactive features, including multimedia dictionaries, English narration, verbal hotspots, and written Chinese translation to facilitate effective learning and parent-child joint engagement. The hotspots embedded in the e-book were congruent with the storyline and the multimedia dictionaries were congruent with the vocabulary included in the story.

TABLE 1 Demographic information of the participants.

Characteristic	Control (N=42)		Treatment (N=69)	
	Mln	SDI%	Mln	SDI%
Children's age (years)	5.19	1.28	5.70	1.08
Parents' age (years)	36.20	4.47	36.40	4.34
Children's gender				
Female	25	59.52%	30	43.48%
Male	17	40.48%	39	56.52%
Monthly family income ^a				
Not willing to tell	3	7.14%	2	2.90%
<10,000¥	7	16.67%	7	10.14%
10,000–30,000¥	24	57.14%	52	75.36%
>30,000¥	8	19.05%	8	11.59%
Parents' educational level				
High school/some college	5	11.90%	9	13.04%
Bachelor's degree	21	50.00%	32	46.38%
Master's degree/above	16	38.10%	28	40.58%

^aThe weighted average of the monthly household income in China was ¥13,834 (approximately \$2000 USD) in 2021.

The discussion prompts were only embedded in the e-book used by the treatment group. The prompts were designed based on two DR strategies: the “C-R-O-W-D” principle and the P-E-E-R sequence (Whitehurst et al., 1994; Zevenbergen & Whitehurst, 2003). The C-R-O-W-D strategies involve prompting the child to say something about the story, evaluating the correctness or completeness of the response, expanding on the response, and repeating the prompt to encourage the child's recall (Whitehurst et al., 1994). Four types of discussion questions were included: (a) recall prompts on previous plots (e.g., “What does little oak look like in the water?”), (b) open-ended prompts (e.g., “If you were one of the butterflies saved by Little Oak, what do you want to say to him at this moment?”), (c) wh-questions that start with why, what, where, when, how on story comprehension (e.g., “Why does nobody notice little oak?”), and (d) distancing prompts that ask about children's own experiences or feelings associated with the story content (e.g., “Have you seen a snake before?”).

There were 10 discussion prompts distributed throughout the story within each reading session, with those in the second session being more difficult than in the first session. Two formats of discussion prompts were used: multiple-choice and short answer. After parents or children selected their response for the multiple-choice questions, automatic feedback was provided in a pop-up window featuring Little Oak, depending on whether they had selected the correct answer (e.g., “Good job.”). An example e-book page can be found in Figure 1.



FIGURE 1 An example of discussion prompts and automatic feedback.

Measures

Strengths and weaknesses of ADHD symptoms and normal behavior rating scale

Children's self-regulation skills were evaluated using the strengths and weaknesses of ADHD symptoms and normal behavior (SWAN) rating scale (Burton et al., 2019; Swanson et al., 2012). Before the first reading session, parents were asked to fill out the SWAN questionnaire, which utilizes a 4-point rating scale. The SWAN scale consists of two subscales that assess the children's inattention (e.g., sustains attention on tasks or play activities) and hyperactivity/impulsivity (e.g., awaits turn by standing in line and taking turns), respectively. Each subscale consists of nine items and the scores of each subscale range from 0 to 9, with higher scores indicating weaker self-regulation skills. A score of six or higher in either subscale indicates that children are at risk of ADHD. Mean Cronbach's alpha for the SWAN scales was $\alpha = .88$ (Swanson et al., 2012). The SWAN scale was translated into Chinese (Lai et al., 2011) and the internal consistency of the Chinese version of the SWAN scale was high (Cronbach's $\alpha = .93$). The Cronbach's alpha coefficients for the inattention and hyperactivity subscales were .81 and .85, respectively.

Story comprehension test

The assessment of story comprehension involved a verbal test that was conducted after the second reading session in order to gauge the children's understanding of the story. The test consisted of seven question sets, including three

yes or no questions (one point for each question, e.g., Did Little Oak use his camouflage when saving his friends?) and seven "wh" questions (three points for each question, e.g., "Why does Little Oak cry at the beginning?"), yielding a total score of 24. Example scoring rubrics are provided for the two types of questions in Appendix A. To ensure inter-rater reliability, all examiners were trained by the first author and achieved a reliability of over 90%. The Cronbach's alpha for the story comprehension test was $\alpha = .85$, indicating good internal consistency.

Children's verbal engagement

We measured the level of verbal engagement of children during the two reading sessions by counting the number of words they produced. Specifically, we measured English and Chinese verbalization separately by counting the number of English words and Chinese characters spoken by the children. To obtain these measures, we transcribed the video recordings of the two reading sessions using the Computerized Language ANalysis program (CLAN; MacWhinney, 2000) and then extracted the number of English words and Chinese characters spoken by the children using the PyLangAcq (Lee et al., 2016) in Python. PyLangAcq is a Python library which provides direct support and powerful extensions for analyzing CHAT-formatted conversational datasets generated by the CLAN program. To ensure accuracy and consistency in the transcription and word counting process, the six research assistants were trained by the lead researcher and achieved an inter-rater reliability of 95%.

Chinese listening comprehension

We measured children's baseline Chinese literacy skills before they read the e-book using the Listening Comprehension scale adapted from the Oral and Written Language Scales–Second Edition (Carrow-Woolfolk, 2011). The scale was translated into Chinese by a research assistant who was proficient in both Chinese and English. The test consisted of 15 questions in which children had to select the correct pictures based on the examiner's description. The total possible score of this test ranged from 0 to 15 with each question worth 1 point and alpha was 0.7.

English letter word identification

The Woodcock-Johnson III Letter Word Identification (Schrank, 2011) was used to assess children's English proficiency prior to the two reading sessions. The test required children either to select the correct English alphabet or word that the examiner read, or to read aloud a chosen alphabet or word from a vocabulary list that increased in difficulty. Due to the limited English skills of the participants, instructions were given in Chinese. The test consisted of 40 questions worth 1 point each. The median reliability reached 0.9 (Schrank, 2011).

Study procedures

In the larger study, parents completed the online SWAN rating scale to assess their children's attention and self-regulation skills prior to the experiment. Following this, participants were randomly assigned to either the treatment or control group. The researchers in the previous study intentionally assigned more children to the treatment group for the purpose of collecting more data on the user experiences of using the e-book with discussion prompts (1.5 times than control, Yang et al., 2022). Children in the treatment group read an interactive Chinese–English bilingual e-book with embedded discussion prompts twice with their parents, while children in the control group read the same e-book without discussion prompts twice with their parents.

The two reading sessions were scheduled over two consecutive days at times that were convenient for the parents. Parents were informed that there was no set duration for each reading session and they were encouraged to read the story with their child at a pace that was comfortable for them. Due to COVID-19 restrictions, all study procedures were administered via Zoom meetings. The two reading sessions were also recorded through Zoom, with the parents' consent. Trained research assistants administered the story comprehension test after the second reading session.

Statistical analysis

Spearman rank correlation tests were conducted to examine the relations among the variables due to the non-normal distribution of the data. The variables included children's ages, Chinese and English verbalizations, self-regulation skills, story comprehension scores, Chinese listening comprehension scores, and English letter word identification scores. Treatment was coded as a binary variable, with 1 indicating that the children read the e-book with discussion prompts and 0 indicating that they read the e-book without discussion prompts.

To answer our research questions, we performed three steps of standardized multiple regression analyses with the overall pooled sample. Given the lack of prior investigations on the moderating impact of e-book multimedia features on the relation between children's cognitive skills on story comprehension, particularly when involving parental interaction, our analysis was relatively exploratory. First, we investigated the main effects of self-regulation skills, children's verbalization, and discussion prompts on story comprehension. Next, we introduced a two-way interaction term between self-regulation and children's verbalization into the regression equation to explore how verbalization moderates the relation between self-regulation and story comprehension. Lastly, we included an interaction term between self-regulation skills and treatment in the regression equation to examine the moderating effect of discussion prompts on the association between self-regulation skills and story comprehension. The final equation for the moderated linear regression analysis is presented as Equation 1. Analysis of variance (ANOVA) was used to examine whether adding interaction terms significantly improved the model fit. We also examined the influence of two subdomains of SWAN scales, attentional skills and hyperactivity/impulsivity, using Equation 1 separately. We controlled for children's age, Chinese listening comprehension score, and English letter word identification score throughout all the regression analyses. The variables were standardized before we entered them into the regression equation. To reduce the potential inflation of type I errors, *p* values in each linear regression model were adjusted with Benjamini–Hochberg procedures (Benjamini & Hochberg, 1995).

$$\begin{aligned} \text{Story Comprehension} = & \beta_0 + \beta_1 \text{ Self-regulation Score} + \beta_2 \text{ Treatment} \\ & + \beta_3 \text{ Verbalization} + \beta_4 \text{ Self-regulation Score Verbalization} \\ & + \beta_5 \text{ Self-regulation Score Treatment} + \dots + \beta_n \text{ Controlled Variables} + e. \end{aligned} \quad (1)$$

After developing the above model, simple slope regression was used to further investigate and visualize the interactions. To illustrate the interaction between children's verbalization and self-regulation, we categorized the children into two groups based on their self-regulation skills: those with high scores (>mean score) and those with low scores (<mean score). We then

conducted separate analyses using Equation (1) within each group to observe how the relation between verbalization and story comprehension differed depending on the self-regulation skill. Similarly, we followed the same procedure to explore the interaction between discussion prompts and self-regulation. We ran Equation (1) with treatment coded as 0 and 1 to examine how the relation between self-regulation skill and story comprehension varied between the two groups. All analyses were conducted using R 4.1.2.

RESULTS

The descriptive analysis results are summarized in Table 2 and the correlational analysis results are presented in Table 3. The findings revealed that decreased self-regulation, measured by the SWAN score, was correlated with lower story comprehension score ($\rho = -.28$, $p < .01$). Furthermore, a positive correlation was found between children's English verbalization and story comprehension ($\rho = .21$, $p = .03$), while Chinese verbalization was not significantly correlated with story comprehension ($\rho = -.05$, $p = .63$). As such, we did not include the Chinese verbalization variable in our regression analysis. Story comprehension was significantly correlated with children's age ($\rho = .49$, $p < .001$), Chinese listening comprehension score ($\rho = .25$, $p = .01$), and English letter word identification score ($\rho = .26$, $p = .01$), which were all adjusted for in our subsequent analysis.

The main effects of self-regulation skills, children's verbalization, and discussion prompts on story comprehension are shown in Table 4. This multiple linear regression model explained 43.06% of the variance in story comprehension ($F(6, 96) = 13.86$, $p < .001$, adjusted $R^2 = .43$). In addressing the first research question, the analysis revealed that weaker self-regulation was associated with poorer story comprehension ($\beta = -.18$, $p = .02$, adjusted $p = .08$) after accounting for the effects of children's English verbalization, experiment conditions, and controlled variables, though the association was not significant after adjusting the p -value. Specifically, for

every one standard deviation increase in SWAN score, namely decrease in self-regulation skills, story comprehension decreased by .18 standard deviations. We also found that children in the treatment group exhibited a significantly higher average score of .79 standard deviation on story comprehension compared to those in the control group ($\beta = .79$, $p < .001$, adjusted $p < .001$).

As presented in Table 5, we then introduced the interaction term between self-regulation score and children's verbalization into the regression equation. The second linear regression model accounted for 47.78% of the variance, in story comprehension ($F(7, 95) = 14.33$, $p < .001$, adjusted $R^2 = .48$), 4.72% more than the first model. The ANOVA revealed that Model 2 significantly enhanced model fit compared to Model 1 ($F(1, 95) = 10.30$, $p = .002$). Our findings revealed a significant moderating effect ($\beta = .29$, $p = .002$, adjusted $p = .01$) of children's English verbalization on the relation between self-regulation and story comprehension. Furthermore, the interaction term between self-regulation score and discussion prompts was included in the regression model, as shown in Table 6. The third regression model explained 50.93% of the variance in story comprehension ($F(8, 94) = 14.23$, $p < .001$, adjusted $R^2 = .51$), 3.15% more than the second model. Additionally, the ANOVA showed that Model 3 significantly improved model fit compared to Model 2 ($F(1, 94) = 7.11$, $p = .01$). The results indicated a significant moderating effect of discussion prompts on the relation between story comprehension and self-regulation ($\beta = .43$, $p = .01$, adjusted $p = .03$).

As indicated in Tables 7 and 8, the two subdomains of self-regulation, namely inattention ($\beta = -.30$, $p = .02$, adjusted $p = .08$) and hyperactivity/impulsivity ($\beta = -.25$, $p = .02$, adjusted $p = .08$), were found to significantly predict story comprehension before the p -values were adjusted. Children's English verbalization significantly moderated the associations between both inattention and hyperactivity and story comprehension (Inattention: $\beta = .29$, $p < .001$, adjusted $p < .001$; Hyperactivity: $\beta = .29$, $p = .01$, adjusted $p = .03$). However, in terms of the moderating effect of discussion prompts, the results did not indicate a significant effect on the associations

TABLE 2 Descriptive statistics of the quantitative measures.

Measures	Control (N=42)		Treatment (N=69)		t-test
	M	SD	M	SD	t(p)
English verbalization word count	330	421	252	314	1.05 (.30)
Chinese verbalization character count	756	509	1037	1026	-1.92 (.06)
Self-regulation score (SWAN)	3.33	3.48	2.19	3.30	1.71 (.09)
Story comprehension	13.08	6.07	19.10	3.53	-5.19** (.00)
Chinese listening comprehension score	10.00	2.80	10.44	2.41	-0.83 (.41)
English letter word identification score	13.74	12.19	17.58	12.39	-1.57 (.12)

Abbreviation: SWAN, strengths and weaknesses of ADHD symptoms and normal behavior.

* $p < .05$; ** $p < .01$; *** $p < .001$.

TABLE 3 Correlations matrix for children's verbalization, self-regulation, and story comprehension.

Variables	1	2	3	4	5	6
1 Age						
2 English verbalization word count	.32**					
3 Chinese verbalization character count	-.31**	.19*				
4 Self-regulation (SWAN)	-.17*	-.05	.15			
5 English letter word identification	.65**	.29**	-.46**	-.11		
6 Chinese listening comprehension	.56**	.29**	-.29**	-.11	.52**	
7 Story comprehension score	.49**	.21*	-.05	-.28**	.26**	.25*

Abbreviation: SWAN, strengths and weaknesses of ADHD symptoms and normal behavior.

* $p < .05$; ** $p < .01$.

TABLE 4 The linear regression models investigating the main effect of self-regulation, English word count, discussion prompts on children's story comprehension.

	β	95% CI		SE	t	p	Adjusted p
		LL	UL				
(Intercept)	-.47	-.66	-.28	.12	-3.86	.00**	-
Age	.34	.09	.59	.11	3.11	.00**	.01*
Chinese LC	.17	-.02	.41	.09	1.97	.05	.16
English LW	-.14	-.34	.05	.10	-1.41	.16	.16
Self-regulation (SWAN)	-.18	-.32	-.06	.08	-2.35	.02*	.08
English verbalization word count	.14	-.00	.26	.08	1.73	.09	.16
Treatment	.79	.50	1.06	.16	4.90	.00**	.00**

Note: β , The standardized coefficient. Adjusted $R^2 = .43$.

Abbreviations: LC, listening comprehension; LW, letter word identification; SE, standard error; SWAN, strengths and weaknesses of ADHD symptoms and normal behavior.

* $p < .05$. ** $p < .01$.

TABLE 5 The moderated linear regression model investigating the interaction between self-regulation and English word count.

	β	95% CI		SE	t	p	Adjusted p
		LL	UL				
(Intercept)	-.43	-.64	-.23	.12	-3.73	.00**	-
Age	.36	.13	.59	.10	3.46	.00**	.00**
Chinese LC	.12	-.06	.34	.09	1.42	.16	.18
English LW	-.13	-.32	.03	.10	-1.37	.18	.18
Self-regulation (SWAN)	-.13	-.28	.01	.07	-1.73	.09	.18
Treatment	.78	.48	1.02	.15	5.05	.00**	.00**
English verbalization word count	.19	.06	.32	.08	2.46	.02*	.06
Self-regulation \times English word count	.40	.22	.60	.10	4.04	.00**	.01*

Note: β , The standardized coefficient. Adjusted $R^2 = .48$.

Abbreviations: LC, listening comprehension; LW, letter word identification; SE, standard error; SWAN, strengths and weaknesses of ADHD symptoms and normal behavior.

* $p < .05$; ** $p < .01$; *** $p < .001$.

between inattention and hyperactivity with story comprehension (Inattention: $\beta = .32$, $p = .05$, adjusted $p = .21$; Hyperactivity: $\beta = .23$, $p = .14$, adjusted $p = .29$).

To further investigate the interaction between self-regulation skills, total SWAN scores, and discussion prompts as shown in Table 6, we estimated the simple

slopes for the treatment and control groups, respectively. As shown in Figure 2a, the results indicate that the effect of self-regulation on story comprehension was not statistically significant for children reading the e-book with discussion prompts ($\beta = -.14$, $p = .23$), while, for those reading the e-book without discussion prompts, children

TABLE 6 The moderated linear regression model investigating the interactions of self-regulation with both English verbalization and discussion prompts.

	β	95% CI		SE	<i>t</i>	<i>p</i>	Adjusted <i>p</i>
		LL	UL				
(Intercept)	-.38	-.60	-.19	.11	-3.31	.00**	-
Age	.35	.11	.56	.10	3.43	.00**	.01**
Chinese LC	.06	-.09	.27	.09	0.71	.48	.48
English LW	-.11	-.29	.05	.09	-1.17	.24	.48
Self-regulation (SWAN)	-.36	-.65	-.15	.11	-3.19	.00**	.01**
Treatment	.76	.49	1.05	.15	5.10	.00**	.00**
English verbalization word count	.22	.08	.36	.08	2.82	.01**	.02*
Self-regulation × treatment	.43	.08	.77	.16	2.67	.01**	.03*
Self-regulation × English word count	.40	.22	.60	.10	4.04	.00**	.00**

Note: β , The standardized coefficient. Adjusted $R^2 = .51$.

Abbreviations: LC, listening comprehension; LW, letter word identification; SE, standard error; SWAN, strengths and weaknesses of ADHD symptoms and normal behavior.

* $p < .05$; ** $p < .01$; *** $p < .001$.

TABLE 7 The moderated linear regression model investigating the association between inattention, English word count, discussion prompt, and story comprehension.

	β	95% CI		SE	<i>t</i>	<i>p</i>	Adjusted <i>p</i>
		LL	UL				
(Intercept)	-.40	-.62	-.21	.12	3.46	.00**	-
Age	.37	.14	.60	.11	3.53	.00**	.00**
Chinese LC	.12	-.06	.34	.09	1.34	.18	.24
English LW	-.11	-.32	.06	.10	-1.18	.24	.24
Self-regulation: Inattention	-.30	-.60	-.03	.12	-2.44	.02*	.08
Treatment	.74	.45	1.01	.16	4.78	.00**	.00**
English verbalization word count	.14	.02	.27	.08	1.83	.07	.21
Inattention score × treatment	.32	-.03	.67	.16	1.97	.05	.21
Inattention score × English word count	.29	.15	.47	.08	3.48	.00**	.00**

Note: β , The standardized coefficient. Adjusted $R^2 = .4761$.

Abbreviations: LC, listening comprehension; LW, letter word identification; SE, standard error.

* $p < .05$; ** $p < .01$; *** $p < .001$.

TABLE 8 The moderated linear regression model investigating the association between hyperactivity, English word count, discussion prompt, and story comprehension.

	β	95% CI		SE	<i>t</i>	<i>p</i>	Adjusted <i>p</i>
		LL	UL				
(Intercept)	-.43	-.65	-.24	.12	-3.63	.00**	-
Age	.32	.08	.55	.11	3.05	.00**	.02*
Chinese LC	.10	-.09	.34	.09	1.05	0.29	.29
English LW	-.13	-.30	.04	.10	-1.31	0.19	.29
Self-regulation: Hyperactivity score	-.25	-.54	-.03	.11	-2.39	.02*	.08
Treatment	.82	.52	1.09	.15	5.27	.00**	.00**
English verbalization word count	.24	.07	.40	.09	2.77	.01**	.03*
Hyperactivity score × treatment	.23	-.16	.58	.16	1.46	.14	.29
Hyperactivity score × English word count	.29	.07	.54	.11	2.77	.01**	.03*

Note: β , The standardized coefficient. Adjusted $R^2 = .50$.

Abbreviations: LC, listening comprehension; LW, letter word identification; SE, standard error.

* $p < .05$; ** $p < .01$; *** $p < .001$.

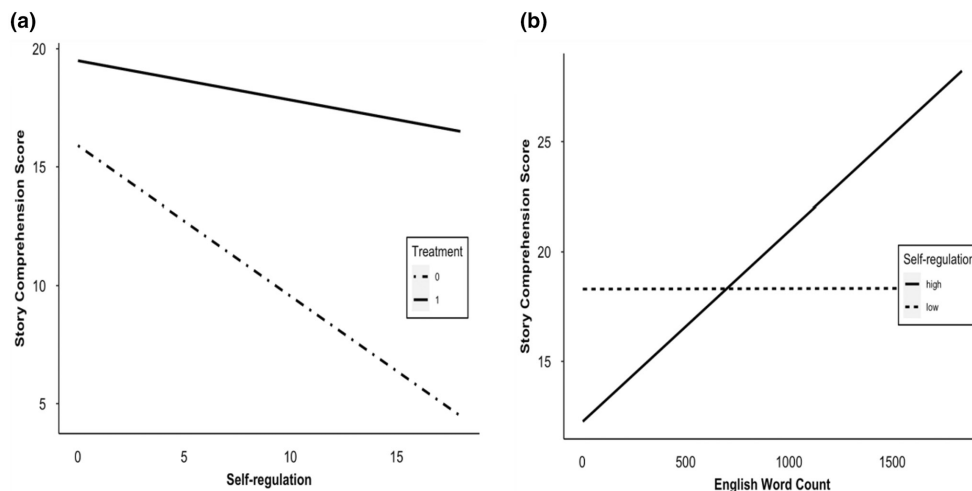


FIGURE 2 (a) The moderating effect of the treatment on the association between self-regulation and story comprehension (0: control group; 1: treatment group). (b) The moderating effect of children's English verbalization (word count) on the association between self-regulation and story comprehension.

with weaker self-regulation skills achieved lower story comprehension scores ($\beta = -.31$, $p = .03$). As shown in Figure 2b, we also estimated the simple slopes at two levels of self-regulation, high ($>$ mean) and low ($<$ mean) groups to further elucidate the interaction between self-regulation skills and children's English verbalization presented in Table 6. For children with lower self-regulation skills, there was no significant effect of English verbalization on story comprehension ($\beta = .07$, $p = .55$), which suggests that children with stronger self-regulation skills remain competent in their story comprehension, regardless of their English verbalization. However, for children with higher self-regulation skills, the comprehension of stories improved significantly with an increase in English verbalization ($\beta = .50$, $p < .001$). In other words, staying verbally engaged in English was particularly beneficial for children with weaker self-regulation skills in better comprehending the story.

DISCUSSION

The current study explored the relation between children's self-regulation skills (measured by inattention/hyperactivity) and story comprehension as well as the effects of discussion prompts embedded in a bilingual e-book on their story comprehension. Consistent with previous findings (e.g., Cain & Bignell, 2014; Kim & Phillips, 2014), our findings made a theoretical contribution to the DIET model (Kim, 2016) by providing empirical evidence for the importance of children's self-regulation abilities such as attentional skills in story comprehension. Our findings extended the literature to the realm of parent-child DR in the digital literacy settings. Earlier research has suggested that children with relatively inattention and hyperactivity may significantly benefit from interactive storybook reading with their

parents or siblings (Dong et al., 2022). In comparison to reading independently, DR enables children with weak cognitive abilities to concentrate more on comprehending the story instead of struggling with decoding words and phrases, which can consume their already limited cognitive capacity (Kim, 2016; Miller et al., 2013). Our study has revealed that, despite the benefits of DR and multimedia features of e-book, there still exists a negative correlation between inattention/hyperactivity and their comprehension outcomes.

One possible explanation for this finding is that story comprehension necessitates learners to remain focused for extended periods while continually receiving informative input and updating their mental representation by forming new connections as they progress through the story (Kim, 2016; Miller et al., 2013). To comprehend narratives successfully, individuals must focus on story elements with higher thematic importance and construct a mental representation of the story using limited cognitive resources (Kim, 2016). Young children, particularly those with weak executive functioning skills, often struggle to maintain attention while reading a story, identify the main thematic information, retain key information in their working memory, and thus fail to grasp a comprehensive understanding of the story.

Although children with weak self-regulation skills (inattention/hyperactivity) tend to struggle with story comprehension compared to their peers, our data are promising in that it demonstrates that embedding discussion prompts in the e-book can moderate this negative association. Specifically, children with a combination of relatively weaker attentional skills and challenges with impulsivity appeared to benefit more from the e-book discussion prompts than their counterparts, and thus, the prompts seem to be a promising strategy to mitigate the effects of weak self-regulation on comprehension. Previous research on e-book discussion prompts has

suggested that embedding such prompts can facilitate parent–child shared reading (Troseth et al., 2020) for children from low SES families and improve story comprehension for English language learners (Yang et al., 2022). Our study is the first to reveal that e-book discussion prompts may bring greater benefits for children with relatively weaker self-regulation including inattention and hyperactivity compared to their counterparts, underscoring the promise of applying discussion prompts in literacy interventions for this group of learners.

A potential explanation for the moderating role of e-book discussion prompt is that it increases opportunities for DR between parents and children, which can sustain children's attention (Hutton et al., 2017), especially for those who have weak attention skills, and increase their engagement (Richter & Courage, 2017) and comprehension outcomes (Dore et al., 2018). One previous study (Yang et al., 2022) suggested that when parents read e-books with discussion prompts, they tend to naturally employ DR strategies (e.g., C-R-O-W-D and P-E-E-R, Zevenbergen & Whitehurst, 2003) and flow, even without specific training. In this study, children were continually prompted with questions while reading e-books with discussion prompts, providing verbal responses and receiving evaluation and feedback, during which their attention was refocused on the story as they were required to recall previous story plots, which served as resources to activate and connect concepts and story events in their memory representation (van de Broek et al., 1999).

Another reason for the benefit of discussion prompts in facilitating comprehension is that it offers opportunities for parent scaffolding. If a child's response involves false information, misunderstandings, or incorrect vocabulary usage, parents and the e-book can elaborate on unfamiliar vocabulary, correct misunderstandings, or review previous story plots together. Conversely, if children's responses are accurate, their memory and comprehension will be reinforced, and positive feedback will be generated from both the e-book and likely the parents as well, which can enhance their engagement and motivation (De Naeghel et al., 2016).

The moderating effect of children's verbal engagement in English on the negative association between their self-regulation skills (inattention/hyperactivity) and story comprehension emphasizes the importance of verbal interaction during storybook reading, particularly for children with weak attentional skills. Our findings indicate that as children with stronger attention skills increase their verbal engagement in English, their story comprehension scores remain consistent. However, for children with weaker attention, the negative impact of inattention and impulsivity on story comprehension is alleviated as they verbalize more in English.

This finding is consistent with the benefits brought by the e-book discussion prompts. Children with sufficient attentional resources may be able to stay focused on reading without the prompts, but children with

inattention or hyperactivity can find it challenging to stay engaged during reading. The prompts embedded in the e-book presented both children and parents with story or vocabulary-related questions in English. As children verbally responded to the questions, parents often asked follow-up questions or prompted the child to say something in English (e.g., “Can you tell me how to say ‘butterfly’ in English?”). This verbal engagement required children to stay attentive, listen to the story carefully, and memorize words or sentences in order to respond. In this way, being verbally engaged turned children into active storytellers instead of passive learners.

During this process, parents had extra opportunities to provide feedback, correct children's pronunciation and misunderstandings of the story. Creating such learning scenarios that scaffold children's focus may be particularly beneficial for those who struggle with attentional control, as observed in our study. By encouraging verbal engagement in English during storybook reading, parents can provide support for children who struggle with self-regulation, such as staying focused, which may promote their comprehension and enhance their overall learning experience.

Furthermore, this finding builds upon existing research affirming the potential cognitive flexibility benefits associated with bilingualism in children, as evidenced by prior studies (e.g., Adesope et al., 2010). It is noteworthy that cognitive flexibility advantages had hitherto been identified primarily in children with a well-balanced proficiency in both languages (Haft et al., 2019); thus, our findings contribute a pivotal empirical component to this body of knowledge by shedding light on the cognitive flexibility advantages present in children with only partial bilingualism or those in the process of acquiring a second language.

Implications

The results of our study highlight the potential of e-book discussion prompts as an effective learning aid for children who struggle with self-regulation skills (inattention/hyperactivity) during shared reading activities. Cognitive science and learning science researchers should consider incorporating discussion prompts in literacy interventions, especially for children with weak attentional skills or those at risk of ADHD. It is worth noting that discussion prompts are not yet a common feature in commercial literacy apps, and concerns exist that embedding discussion prompts in the middle of the story may interrupt children's reading flow. However, evidence from the current study as well as previous study (Yang et al., 2022) suggests that when designed properly, discussion prompts may be helpful to sustain children's attention and beneficial for their story comprehension, especially those with inattention or hyperactivity.

Moreover, our study sheds light on the importance of verbal engagement during shared reading in a second language setting. Parents should encourage their children to talk more in the second language, as active verbal participation can enhance story comprehension, especially for children with attentional difficulties. In this sense, shared reading can become a valuable opportunity for children to develop language skills and attentional abilities, with parents acting as scaffolds to support their learning.

Limitations and future directions

When interpreting the results of the study, it is important to acknowledge some limitations of the study. First, our sample consisted of typically developing children with limited expressions of inattention and impulsivity, and therefore, the findings may not generalize to children with diagnosed ADHD. Although we measured the self-regulatory skills of the children including inattention and hyperactivity, using the SWAN questionnaire, which has been validated as a reliable measure of ADHD symptoms (Soma et al., 2009), it is important to note that this measure does not provide a clinical diagnosis of ADHD. The SWAN rating is reported by parents and may be subject to rater- and social desirability bias. Finally, although it was translated by researchers who were fluent in both English and Chinese and showing comparable reliability estimates, it was not back-translated. Future research should aim to replicate these findings with behavioral observation or assessment of self-regulation or in clinical populations with diagnosed ADHD. Second, the large age range could potentially affect the impact of the discussion prompts and verbal engagement on children's story comprehension. Nevertheless, we have controlled this variable in the regression models, and thus, the influence of age was largely mitigated. Also, due to the constraints of secondary analysis, we could only use the quantity of verbalization to measure verbal engagement. Future studies should explore other types of engagement such as cognitive, behavioral, and emotional engagement.

CONCLUSION

The present study explored the relation between children's self-regulation skills measured by the SWAN rating and their comprehension of an interactive bilingual e-book during parent-child shared reading. Our findings indicate that children with relatively weaker self-regulation skills (inattention and hyperactivity) tended to score lower on comprehension tasks. Notably, children with poorer self-regulation skills benefited more from the e-book embedded with discussion prompts and

verbalizing more in English, compared to their peers. This suggests that well-designed e-books with discussion prompts have the potential to be effective learning tools to promote reading comprehension and literacy development, particularly for children with inattention and hyperactivity.

Furthermore, our study highlights the importance of prompts that require responses in English during shared reading in an EFL setting. These prompts can help redirect children's attention to the story, which is particularly beneficial for those with weaker attentional skills. Overall, our findings demonstrate the value of interactive e-book features, particularly discussion prompts with immediate feedback, in promoting comprehension during shared reading activities with parents. Educators and researchers should consider incorporating well-designed e-books with discussion prompts into literacy interventions for children who struggle with attention and/or those at risk of ADHD.

ACKNOWLEDGMENTS

We would like to express our appreciation to the children and families who participated in the study. Assistance in website development and data collection provided by the research assistants in the Digital Learning Lab and Collin's Literacy Lab at the University of California, Irvine, is also greatly appreciated.

FUNDING INFORMATION

This work was supported by the International Research Foundation (TIRF) for English Language Education Doctoral Dissertation Grant; Duolingo Research Grant; and University of California Office of President Catalyst Award.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data necessary to reproduce the analyses presented here are not publicly accessible. The analytic code necessary to reproduce the analyses presented in this paper is not publicly accessible. Code is available from the second author. The analyses presented here were not preregistered.

ORCID

Dandan Yang  <https://orcid.org/0000-0001-8175-6931>

Penelope Collins  <https://orcid.org/0000-0002-0818-3230>

<https://orcid.org/0000-0002-0818-3230>

Ying Xu  <https://orcid.org/0000-0003-2079-2394>

REFERENCES

- Adesope, O. O., Lavin, T., Thompson, T., & Ungerleider, C. (2010). A systematic review and meta-analysis of the cognitive correlates of bilingualism. *Review of Educational Research, 80*(2), 207–245. <https://doi.org/10.3102/0034654310368803>

- Altun, D. (2022). The effects of e-stories on preschoolers' narrative comprehension, retelling and reading attitudes among poor and good comprehenders. *Journal of Early Childhood Literacy*, 24(2), 471–504.
- Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society: Series B: Methodological*, 57(1), 289–300. <https://doi.org/10.1111/J.2517-6161.1995.TB02031.X>
- Burton, C. L., Wright, L., Shan, J., Xiao, B., Dupuis, A., Goodale, T., Shaheen, S.-M., Corfield, E. C., Arnold, P. D., Schachar, R. J., & Crosbie, J. (2019). SWAN scale for ADHD trait-based genetic research: A validity and polygenic risk study. *Journal of Child Psychology and Psychiatry*, 60(9), 988–997. <https://doi.org/10.1111/jcpp.13032>
- 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), 233285842090149. <https://doi.org/10.1177/2332858420901494>
- Bus, A. G., Takacs, Z. K., & Kegel, C. A. (2015). Affordances and limitations of electronic storybooks for young children's emergent literacy. *Developmental Review*, 35, 79–97. <https://doi.org/10.1016/j.dr.2014.12.004>
- Cain, K., & Bignell, S. (2014). Reading and listening comprehension and their relation to inattention and hyperactivity. *British Journal of Educational Psychology*, 84(1), 108–124. <https://doi.org/10.1111/bjep.12009>
- Cain, K., & Oakhill, J. (2011). Reading comprehension development from 8 to 14 years: The contribution of component skills and processes. In K. Cain & J. Oakhill (Eds.), *Children's comprehension problems in Oral and written language: A cognitive perspective* (pp. 60–76). Guilford Press.
- Carrow-Woolfolk, E. (2011). *Oral and Written Language Scales—Second Edition (OWLS-II)*. Pearson Assessment.
- Chow, B. W., McBride-Chang, C., & Cheung, H. (2010). Parent-child reading in English as a second language: Effects on language and literacy development of Chinese kindergarteners. *Journal of Research in Reading*, 33(3), 284–301. <https://doi.org/10.1111/j.1467-9817.2009.01414.x>
- Claussen, A. H., Robinson, L. R., Kaminski, J. W., Charania, S., Holbrook, J. R., So, M., Ghandour, R., Smith, C., Satterfield-Nash, A., Peacock, G., & Boyle, C. (2021). Factors associated with self-regulation in a nationally representative sample of children ages 3–5 years: United States, 2016. *Maternal and Child Health Journal*, 25(1), 27–37. <https://doi.org/10.1007/s10995-020-03039-6>
- De Naeghel, J., Van Keer, H., Vansteenkiste, M., Haerens, L., & Aelterman, N. (2016). Promoting elementary school students' autonomous reading motivation: Effects of a teacher professional development workshop. *The Journal of Educational Research*, 109(3), 232–252.
- Dickinson, D. K., & Porche, M. V. (2011). Relation between language experiences in preschool classrooms and children's kindergarten and fourth-grade language and reading abilities. *Child Development*, 82(3), 870–886. <https://doi.org/10.1111/j.1467-8624.2010.01520.x>
- Dong, Y., Chow, B. W., Mo, J., & Zheng, H. (2022). Dialogic reading with attention-deficit-hyperactivity disorder (ADHD) kindergarteners: Does reading with parents or siblings enhance their language development? *Developmental Psychology*, 59, 862–873. <https://doi.org/10.1037/dev0001466>
- 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. <https://doi.org/10.1016/j.ecresq.2018.02.002>
- Ertem, I. S. (2010). The effect of electronic storybooks on struggling fourth-graders' reading comprehension. *The Turkish Online Journal of Educational Technology*, 9, 140–155.
- Furenes, M. I., Kucirkova, N., & Bus, A. G. (2021). A comparison of children's reading on paper versus screen: A meta-analysis. *Review of Educational Research*, 91(4), 483–517.
- Ganotice, F. A., Downing, K., Mak, T., Chan, B., & Lee, W. Y. (2016). Enhancing parent-child relationship through dialogic reading. *Educational Studies*, 43(1), 51–66. <https://doi.org/10.1080/03055698.2016.1238340>
- Haft, S. L., Kepinska, O., Caballero, J. N., Carreiras, M., & Hoeft, F. (2019). Attentional fluctuations, cognitive flexibility, and bilingualism in kindergarteners. *Behavioral Sciences*, 9(5), 58.
- Hoffman, J. L., & Paciga, K. A. (2013). Click, swipe, and read: Sharing e-books with toddlers and preschoolers. *Early Childhood Education Journal*, 42(6), 379–388. <https://doi.org/10.1007/s10643-013-0622-5>
- Hutton, J. S., Phelan, K., Horowitz-Kraus, T., Dudley, J., Altaye, M., DeWitt, T., & Holland, S. K. (2017). Story time turbocharger? Child engagement during shared reading and cerebellar activation and connectivity in preschool-age children listening to stories. *PLoS One*, 12(5), e0177398. <https://doi.org/10.1371/journal.pone.0177398>
- Kim, Y., & Phillips, B. (2014). Cognitive correlates of listening comprehension. *Reading Research Quarterly*, 49(3), 269–281. <https://doi.org/10.1002/rrq.74>
- Kim, Y. G. (2016). Direct and mediated effects of language and cognitive skills on comprehension of oral narrative texts (listening comprehension) for children. *Journal of Experimental Child Psychology*, 141, 101–120. <https://doi.org/10.1016/j.jecp.2015.08.003>
- Lai, K. Y., Leung, P. W., Luk, E. S., Wong, A. S., Law, L. S., & Ho, K. K. (2011). Validation of the Chinese strengths and weaknesses of ADHD-symptoms and normal-behaviors questionnaire in Hong Kong. *Journal of Attention Disorders*, 17(3), 194–202. <https://doi.org/10.1177/1087054711430711>
- Lee, J. L., Burkholder, R., Flinn, G. B., & Coppess, E. R. (2016). *Working with CHAT transcripts in Python*. Technical report TR-2016-02. Department of Computer Science, University of Chicago.
- Li, H., Zhang, T., Woolley, J. D., An, J., & Wang, F. (2023). Exploring factors influencing young children's learning from storybooks: Interactive and multimedia features. *Journal of Experimental Child Psychology*, 233, 105680. <https://doi.org/10.1016/j.jecp.2023.105680>
- Lim, J., Whitehead, G. E., & Choi, Y. (2021). Interactive e-book reading vs. paper-based reading: Comparing the effects of different mediums on middle school students' reading comprehension. *System*, 97, 102434. <https://doi.org/10.1016/j.system.2020.102434>
- MacWhinney, B. (2000). *The CHILDES project: Tools for analyzing talk* (3rd ed.). Lawrence Erlbaum Associates.
- McClelland, M. M., Cameron, C. E., Connor, C. M., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology*, 43(4), 947–959. <https://doi.org/10.1037/0012-1649.43.4.947>
- Miller, A. C., Keenan, J. M., Betjemann, R. S., Willcutt, E. G., Pennington, B. F., & Olson, R. K. (2013). Reading comprehension in children with ADHD: Cognitive underpinnings of the centrality deficit. *Journal of Abnormal Child Psychology*, 41(3), 473–483. <https://doi.org/10.1007/s10802-012-9686-8>
- Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., Houts, R., Poulton, R., Roberts, B. W., Ross, S., Sears, M. R., Thomson, W. M., & Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences of the United States of America*, 108(7), 2693–2698. <https://doi.org/10.1073/pnas.1010076108>
- 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(1), 7–26. <https://doi.org/10.1080/10409280701838603>
- Nelson, J. M., Kershaw, S., & Gowda, S. M. (2017). The simple view of reading, oral reading fluency, and academic achievement of middle school students with learning disabilities: A longitudinal examination. *Learning Disabilities Research & Practice*, 32(3), 159–169. <https://doi.org/10.1111/ldrp.12134>

- Niu, W., Cheng, L., Xu, W., Zhang, Q., & Zhang, X. (2021). Improving resilience of a child with ADHD: A context specific intervention program through dialogic and guided reading. *International Journal of Disability, Development and Education*, 68(6), 788–805. <https://doi.org/10.1080/1034912x.2021.1929085>
- Noble, C., Cameron-Faulkner, T., Jessop, A., Coates, A., Sawyer, H., Taylor-Ims, R., & Rowland, C. F. (2020). The impact of interactive shared book reading on children's language skills: A randomized controlled trial. *Journal of Speech, Language, and Hearing Research*, 63(6), 1878–1897. https://doi.org/10.1044/2020_jslhr-19-00288
- Paas, F., & Sweller, J. (2014). Implications of cognitive load theory for multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 27–42). Cambridge University Press. <https://doi.org/10.1017/CBO9781139547369.004>
- Papaeliou, C. F., Maniadaki, K., & Kakourou, E. (2012). Association between story recall and other language abilities in schoolchildren with ADHD. *Journal of Attention Disorders*, 19(1), 53–62. <https://doi.org/10.1177/1087054712446812>
- Pillinger, C., & Wood, C. (2014). Pilot study evaluating the impact of dialogic reading and shared reading at transition to primary school: Early literacy skills and parental attitudes. *Literacy*, 48(3), 155–163. <https://doi.org/10.1111/lit.12018>
- Rahn, N. L., Coogle, C. G., & Storie, S. (2016). Preschool children's use of thematic vocabulary during dialogic reading and activity-based intervention. *The Journal of Special Education*, 50(2), 98–108. <https://doi.org/10.1177/0022466915622202>
- Retter, S., Anderson, C., & Kieran, L. (2013). iPad use for accelerating gains in reading skills of secondary students with learning disabilities. *Journal of Educational Multimedia and Hypermedia*, 22(4), 443–463.
- Richter, A., & Courage, M. L. (2017). Comparing electronic and paper storybooks for preschoolers: Attention, engagement, and recall. *Journal of Applied Developmental Psychology*, 48, 92–102. <https://doi.org/10.1016/j.appdev.2017.01.002>
- Ronimus, M., Eklund, K., Pesu, L., & Lyytinen, H. (2019). Supporting struggling readers with digital game-based learning. *Educational Technology Research and Development*, 67, 639–663. <https://doi.org/10.1007/s11423-019-09658-3>
- Schachar, R., & Logan, G. D. (1990). Impulsivity and inhibitory control in normal development and childhood psychopathology. *Developmental Psychology*, 26(5), 710–720. <https://doi.org/10.1037/0012-1649.26.5.710>
- Schrank, F. A. (2011). Woodcock-Johnson III tests of cognitive abilities. In A. S. Davis (Ed.), *Handbook of pediatric neuropsychology* (pp. 415–434). Springer Publishing Company.
- Simsek, Z. C., & Erdogan, N. I. (2015). Effects of the dialogic and traditional reading techniques on children's language development. *Procedia—Social and Behavioral Sciences*, 197, 754–758. <https://doi.org/10.1016/j.sbspro.2015.07.172>
- Skarakis-Doyle, E., & Dempsey, L. (2008). Assessing story comprehension in preschool children. *Topics in Language Disorders*, 28(2), 131–148. <https://doi.org/10.1097/01.tld.0000318934.54548.7f>
- Smeets, D. J., & Bus, A. G. (2014). The interactive animated e-book as a word learning device for kindergartners. *Applied PsychoLinguistics*, 36(4), 899–920. <https://doi.org/10.1017/s0142716413000556>
- Soma, Y., Nakamura, K., Oyama, M., Tsuchiya, Y., & Yamamoto, M. (2009). Prevalence of attention-deficit/hyperactivity disorder (ADHD) symptoms in preschool children: Discrepancy between parent and teacher evaluations. *Environmental Health and Preventive Medicine*, 14(2), 150–154. <https://doi.org/10.1007/s12199-008-0075-4>
- Strasser, K., & Río, F. D. (2013). The role of comprehension monitoring, theory of mind, and vocabulary depth in predicting story comprehension and recall of kindergarten children. *Reading Research Quarterly*, 49(2), 169–187. <https://doi.org/10.1002/rrq.68>
- Sun, H., Loh, J. Y., & Roberts, A. C. (2019). Motion and sound in animated storybooks for preschooler's total fixation time and mandarin language learning: An eye-tracking study with Singaporean bilingual children. *AERA Open*, 5(2), 1–19. <https://doi.org/10.1177/2332858419848431>
- Sun, H., Roberts, A. C., & Bus, A. (2022). Bilingual children's visual attention while reading digital picture books and story retelling. *Journal of Experimental Child Psychology*, 215, 105327. <https://doi.org/10.1016/j.jecp.2021.105327>
- Swanson, J. M., Schuck, S., Porter, M. M., Carlson, C., Hartman, C. A., Sergeant, J. A., Clevenger, W., Wasdell, M., McCleary, R., Lakes, K., & Wigal, T. (2012). Categorical and dimensional definitions and evaluations of symptoms of ADHD: History of the SNAP and the SWAN rating scales. *The International Journal of Educational and Psychological Assessment*, 10(1), 51–70.
- Takacs, Z. K., & Bus, A. G. (2016). Benefits of motion in animated storybooks for children's visual attention and story comprehension. An eye-tracking study. *Frontiers in Psychology*, 7, 1591. <https://doi.org/10.3389/fpsyg.2016.01591>
- Takacs, Z. K., Swart, E. K., & Bus, A. G. (2015). Benefits and pitfalls of multimedia and interactive features in technology-enhanced storybooks: A meta-analysis. *Review of Educational Research*, 85(4), 698–739. <https://doi.org/10.3102/0034654314566989>
- 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. <https://doi.org/10.1016/j.ecresq.2019.02.009>
- Twait, E., Farah, R., Shamir, N., & Horowitz-Kraus, T. (2019). Dialogic reading vs screen exposure intervention is related to increased cognitive control in preschool-age children. *Acta Paediatrica*, 108(11), 1993–2000. <https://doi.org/10.1111/apa.14841>
- Van den Broek, P., Young, M., Tzeng, Y., & Linderholm, T. (1999). The landscape model of reading: Inferences and the online construction of a memory representation. *The construction of mental representations during reading*, 71–98.
- Van Dijk, T. A., & Kintsch, W. (1983). *Strategies of discourse comprehension*. Academic Press.
- Verhoeven, L., Reitsma, P., & Siegel, L. S. (2011). Cognitive and linguistic factors in reading acquisition. *Reading and Writing*, 24(4), 387–394. <https://doi.org/10.1007/s11145-010-9232-4>
- Whitehurst, G. J., Epstein, J. N., Angell, A. L., Payne, A. C., Crone, D. A., & Fischel, J. E. (1994). Outcomes of an emergent literacy intervention in Head Start. *Journal of Educational Psychology*, 86, 542–555. <https://doi.org/10.1037/0022-0663.86.4.542>
- Whitehurst, G. J., Falco, F. L., Lonigan, C. J., Fischel, J. E., DeBryshe, B. D., Valdez-Menchaca, M. C., & Caulfield, M. (1988). Accelerating language development through picture book reading. *Developmental Psychology*, 24, 552–559.
- Yang, D., Xia, C., Collins, P., & Warschauer, M. (2022). The role of bilingual discussion prompts in shared E-book reading. *Computers & Education*, 190, 104622.
- Yow, W. Q., & Priyashri, S. (2019). Computerized electronic features direct children's attention to print in single-and dual-language e-books. *AERA Open*, 5(3), 2332858419878126. <https://doi.org/10.1177/2332858419878126>
- Zevenbergen, A. A., & Whitehurst, G. J. (2003). Dialogic reading: A shared picture book reading intervention for preschoolers. In A. Van Kleeck, S. A. Stahl, & E. B. Bauer (Eds.), *On reading books to children: Parents and teachers* (pp. 170–200). Lawrence Erlbaum.

How to cite this article: Yang, D., Ge, Y., Sun, Y., Collins, P., Jaeggi, S. M., Xu, Y., Shea, Z. M., & Warschauer, M. (2024). Self-regulation and comprehension in shared reading: The moderating effects of verbal interactions and E-book discussion prompts. *Child Development*, 95, 1934–1949. <https://doi.org/10.1111/cdev.14128>

APPENDIX A

EXAMPLES OF THE STORY COMPREHENSION SCORING RUBRICS

Question Set 1:

- *Did Little Oak use his camouflage when saving his friends?*
- *If so, how?*

The scoring rubric for “Did Little Oak use his camouflage when saving his friends?”

Scale	Criteria
1	The child says yes
0	The child says no or did not answer.

The scoring rubric for “How?”

Scale	Criteria
3	The child gives the correct answer by describing that while passing the guards, Little oak used his dry-leaf wings and pretended that he was a dry leaf
2	The child gives partially correct answer: e.g., “he hid in the tree”
1	Mentions on-topic words or phrases but did not cover the main idea of the right answer: e.g., “his dry-leave wings are awesome”
0	The child does not say anything or say irrelevant things or did not understand the question. E.g., “I don’t know.” Or if the child scores 0 for the first question