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Dialogic reading (DR) is an interactive reading approach that enhances the language development of children. This study aims to extend DR to the shared reading context involving children with attention-deficit-hyperactivity disorder (ADHD) and their older siblings and to examine the effects of DR with parents/siblings on the language development of Chinese children with ADHD. This study included 850 Chinese kindergarteners with ADHD and their parents/older siblings. These children were pretested on their Chinese receptive vocabulary, expressive vocabulary, character reading, listening comprehension, and reading interest and were randomly assigned to four groups, namely, dialogic reading with parents (PR-DR), dialogic reading with siblings (SR-DR), parent reading control (PR-C), and sibling reading control (SR-C). After a 12-week intervention period, they were posttested on the same measures. Results show that both DR with parents and siblings effectively enhanced language skills and reading interest in children with ADHD. In addition, those children who read with their older siblings demonstrated greater improvements in their expressive vocabulary, character reading skills, morphological awareness, phonological awareness, and reading interest yet achieved a smaller growth in their listening comprehension compared with those who read with their parents. These findings showed the positive effects of DR on the language development of children with ADHD and highlight the importance of involving siblings in home literacy activities to facilitate the language development of these children.

Public Significance Statement
This study highlights the positive impacts of DR and reading with parents or older siblings on ADHD children's language development. It suggests DR as a useful method that effectively involves not only parents but also older siblings in facilitating language learning in ADHD children.

Keywords: dialogic reading, ADHD, sibling, parents, kindergarteners

Dialogic reading (DR) is an interactive reading approach that enhances the language and literacy development of children (Chow et al., 2018, 2021; Whitehurst et al., 1988; Zevenbergen et al., 2003). While the positive effects of DR on language skills and reading interest in children have been demonstrated, its influence on children with attention-deficit-hyperactivity disorder (ADHD) remains unclear. ADHD children faced challenges in maintaining attention during learning activities. Also, past studies reported ADHD children

had lower reading interest than typically developing (TD) children and intrinsic reading interest positively predicted reading performance (Lee & Zentall, 2017; Smith et al., 2020). Therefore, investigating methods to enhance their engagement in reading activities and reading interest are particularly important. Moreover, previous studies have mostly focused on parent–child and teacher–student DR, and whether DR can be implemented by siblings requires investigation. This study aims to extend previous research by investigating the effects of DR on ADHD kindergarteners and comparing the effects of DR delivered by parents or older siblings.

Language Learning in ADHD Children

ADHD is a neurodevelopmental disorder characterized by inattention and/or hyperactivity-impulsivity with a 5% average global prevalence (Leonard et al., 2009; Niu et al., 2021; Winsler, 1998). Children with ADHD usually experience learning difficulties and psychological distress due to attentional disorders (Niu et al., 2021). In early childhood reading activities, ADHD children face challenges in using the story structure or cues to retrieve the required information, understanding the causal relations among the story events, monitoring their self-reading progress, and drawing rational inferences (e.g., coherent story representation) based on the given narrative stories (Lorch et al., 2007; Martinussen & Mackenzie, 2015; Niu et al., 2021).

Preschool years represent a critical time for ADHD children to develop their language skills and reading interest that they need to succeed in school (Leonard et al., 2009; Winsler, 1998; Xu et al., 2022). Home literacy activities provide a prime context for bolstering the language development of children. Sociocultural theory (John-Steiner & Mahn, 1996) regards language development as a mediated process in which children acquire language skills through collaborative or interactive dialogue with more knowledgeable family members in home language activities. Through an interactive back-and-forth conversation with more knowledgeable language educators who provide scaffolding and facilitate active participation, children internalize knowledge by focusing their attention, expressing their thoughts, answering questions, and critically reflecting on the topic being discussed (Golinkoff et al., 2019; Xu et al., 2022). Parent–child interaction and scaffolding facilitate the speech ability development of ADHD children (Winsler, 1998). Sociocultural theory (John-Steiner & Mahn, 1996) also recommends that educators should create a language environment that is developmentally appropriate for children. One way to create this environment is to encourage children to positively participate in shared reading, which has been found to effectively enhance the vocabulary learning, language comprehension, expressive language, and reading interest development of ADHD children (Ahmed, 2018; Leonard et al., 2009; Niu et al., 2021; Sénéchal, 2017).

Dialogic Reading

DR is a shared book reading approach in which an older or knowledgeable educator (e.g., parents or teacher) engages in dialogue with a language learner (e.g., kindergarteners) through interactive question-and-answer communication while reading together (Whitehurst et al., 1988; Zevenbergen et al., 2003). DR comprises four essential sequences called PEER, which include (a) the educator prompts the language learners to talk about the stories (P: *prompt*); (b) the educator checks whether the responses of these learners are accurate (E: *evaluate*); (c) the educator asks further questions about the story (E: *expand*); and (d) the educator encourages learners to repeat the expanded contents (R: *repeat*). To facilitate the communication or discussion between educators and learners and to help the latter describe and retell the story better, Zevenbergen and Whitehurst (2008) proposed five types of prompt questions called CROWD, which include (a) the educator asking learners to complete a sentence (C: *completion*); (b) the educator asking learners to recall details about the story (R: *recall*); (c) the educator asking learners open-ended questions without definite answers (O: *open-ended questioning*); (d) the educator asking learners some "wh-" questions, including what, why, who, when, where, and how (W: *wh- questions*); and (e) the educator asking learners to relate events in the story to their own experiences (D: *distancing*). Past studies have reported that DR is an effective approach for enhancing the language ability and reading interest development of kindergarten and primary school students (Ahmed, 2018; Chow et al., 2009, 2018, 2021; Leonard et al., 2009; Sénéchal, 2017; Winsler, 1998). While most of the DR research has been conducted on typically developing children, the effects of DR on ADHD children remain unclear. To extend past research, this study investigates the effects of DR on ADHD kindergarteners. In addition, past studies have demonstrated that parent–child relationship and frequency of home interactive activities contributed to children's learning outcomes (e.g., Dong & Chow, 2022; Goodman et al., 2008; Zhou et al., 2006). The effects of DR on children's language learning with these variables taken into account will be examined in this study.

Role of Siblings in the Language Development of Children

Apart from parents, older siblings are essential family members who engage in interactive literacy communication with younger children. The social learning perspective model (SLPM; Bandura, 1992) posits that relative to family guardians (e.g., parents), older siblings have a greater potentially positive impact on the language development of younger children because of their close age and generational experience (Eckstein et al., 2018; Spector & Charlop, 2018). Older siblings also serve as sources of a language learning model for younger children during their preschool years (Eckstein et al., 2018; Milevsky, 2016; Obied, 2009). For example, Eckstein et al. (2018) showed that younger sisters showed a significantly better performance in their vocabulary after a learning interaction with their older siblings. Empirical research has supported the use of older siblings–instructional interventions in enhancing the receptive vocabulary development of younger children (e.g., Shivers & Plavnick, 2015). However, to the best of our knowledge, the effect of the DR implementation by older siblings on younger children remains unknown, and only few empirical studies have investigated the effect of such shared reading on the language and reading interest development of ADHD children.

The Present Study

This study extends past research by examining the effects of DR delivered by parents or older siblings on the language skills and reading interest of ADHD children. This study included Chinese ADHD kindergarteners and their parents/siblings. Three

research questions were proposed. First, does DR with parents enhance the language skills and reading interest of ADHD children? As DR encourages parent–child interactive dialogues, children have more opportunities to listen to and actively use the language, which facilitates the growth of their language skills, including receptive and expressive vocabulary knowledge, listening comprehension, phonological awareness and morphological awareness. When parents read aloud printed words in the storybooks, they discuss these words with their children during DR, and this facilitates the children's character reading. Also, DR promote children's active participation in reading, and sharing of their ideas and daily experiences related to the storybook content, and this increases children's reading interest. In this study, we hypothesize that DR with parents will enhance the language skills and reading interest of children. Second, does DR with siblings enhance the language skills and reading interest of ADHD children? We hypothesize that DR with siblings will enhance the language skills and reading interest of these children. Third, do DR with parents and DR with siblings have different impact patterns on the language development of children? According to sociocultural theory (John-Steiner & Mahn, 1996), given that parents have a higher language proficiency than siblings, DR with parents will provide greater benefits for the language learning of children compared with DR with siblings. However, SLPM posits that DR with siblings offers greater benefits on the language learning of children than DR with parents because of the close age and generational learning experience of older siblings. These effects are compared in this study.

Method

Participants

Sample size was estimated based on expected dropout and power calculation. According to the sample size suggestion from G power 3.1, results showed that the minimum sample size for each group should be 112. With the approval of by the medical centers Institutional Review Board and participants' agreement to use the ADHD clinical registry recordings, this study recruited 1,030 families from six citizen medical centers in Dongguan, China. Each of these families had at least two children at home, with one child aged around 5 years diagnosed with ADHD by a doctor from the medical center, and his or her sibling is a secondary Grade 7 or Grade 8 student with no special educational needs. Children in Dongguan received a psychological assessment on special educational needs, when they entered kindergarten at around the age of 3. ADHD children included in the current study were diagnosed by licensed clinical psychologists in this assessment. ADHD diagnostic procedure included a clinic-developed semistructured interview assessing ADHD symptoms and additional Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria for ADHD (i.e., age of onset, functional impairments, and ruling out possible other causes [e.g., mood, anxiety, and adjustment] for ADHD symptomatology). These families had low to middle income (earning 3,100 RMB to 8,605 RMB per month). All 1,030 ADHD children were third-year kindergarteners. A total of 180 families dropped out from the study, resulting in 850 families being included in the analysis.

Measures

This study included seven outcome measures, including receptive vocabulary, expressive vocabulary, character reading, morphological awareness, phonological awareness, listening comprehension, and reading interest. Nonverbal intelligence, family members intimacy, and demographical variables were included as control variables.

Receptive Vocabulary

The revised 60-item Chinese receptive vocabulary test was developed by Tong et al.'s (2017) Chinese Vocabulary Knowledge test which was adapted and presented in Mandarin. The children were asked to orally report the answer of picture selection task which matched the semantic meaning of a one- or two-character word said twice by the experimenter. This test had a maximum score of 60 and a Cronbach's α of .91.

Expressive Vocabulary

This study adapted 60 items from the Chinese version of the expressive vocabulary test developed by Martin and Brownell (2011). In each item, the children were asked to orally produce a word that best represented a given picture. This test had a maximum score of 60 and a Cronbach's α of .89.

Character Reading

The Mandarin version of the 120-item Chinese character reading test was adopted (Kim et al., 2020). The children were asked to read aloud every word presented on a paper. The test stopped when these children failed to read 15 items consecutively. This test had a maximum score of 120 and a Cronbach's α of .91.

Morphological Awareness

The lexical level morphological awareness task of Tong et al. (2017) was adapted and presented in Mandarin. The experimenter orally presented each question (e.g., concept or object) to the students, and then the children orally reported their answers. One example item is "There is one type of oil (油) made from peanuts (花生), and we call it peanut oil (花生油). What should we call a type of oil (油) that is made from beans (大豆)?," to which the correct answer is "bean oil (大豆油)." This test included two practice items and 20 test items. The test was stopped when the children failed to read four items consecutively. The test had a maximum score of 20 and a Cronbach's α of .93.

Phonological Awareness

The syllable deletion task was used to measure the Chinese phonological awareness of the students (Tong et al., 2017). This task comprised three practice items and 16 three-syllable phrase items, of which eight were real word phrases and eight were nonword phrases. The experimenter read each item aloud to the students, and then the children were asked to take away one syllable from the three-syllable phrases. Four items required the deletion of the first syllable, four items required the deletion of the last syllable, and eight items required the deletion of the middle syllable. An example item is "What is 'birthday cake' without 'cake'?," to which the correct answer is "birthday cake." The test was stopped when the children failed to answer five items consecutively. Each correct answer was awarded a score of 1. The test had a maximum score of 16 and a Cronbach's α of .92.

Listening Comprehension

The listening comprehension ability of the children was tested by using 15- to 20-character sentences selected from the listening comprehension component of Hanyushuipingkaoshi-level 5 (HSK-5, 2017). The listening comprehension test included 20 items. The experimenter orally presented each sentence to the children twice, and then the children were asked to select one out of four pictures that best describes the presented items. The test was stopped when the children made four errors consecutively. The test had a maximum score of 20 and a Cronbach's α of .68.

Reading Interest Questionnaire

The reading interest scale of Zhang and Xin (2012) was adapted and presented in Mandarin. The questionnaire included 6 items (e.g., "Reading books really attracts my attention"). The experimenter read each question aloud twice, and then the children were asked to select a rating on a 4-point scale (1 = *strongly disagree* to 4 = *strongly agree*) that best matches their own reading interest. The scale had a maximum score of 24 and a Cronbach's α of .79.

Nonverbal Intelligence

Standard progressive matrices were used in this study (Raven et al., 1996). Each of the five sections contained 12 items. In each item, the children were asked to select one out of six to eight pieces to match the pattern of a given picture. The test had a maximum score of 60 and a Cronbach's α of .89.

Intimacy Questionnaire

The family members intimacy questionnaire of Sun (2014) was revised into the siblings' intimacy scale and the parent–child intimacy scale by specifying siblings and parents in the items, respectively, with each scale comprising 16 items (e.g., "My parents and I have a very close relationship"). The experimenter read each item aloud twice, and the children were asked to rate these items on a 5-point scale (1 = *strongly disagree* to 5 = *strongly agree*). A higher score corresponded to a higher level of intimacy between ADHD children and their parents or siblings. The questionnaire had a maximum score of 80 and Cronbach's α of .92 and .93 for the intimacy scales of siblings and parents, respectively. Confirmatory factor analysis (CFA) results indicate that the revised scales can be used to examine the intimacy correlation of children with their siblings and parents (siblings' scale: $\chi^2/df = 1.37$ ($p > .05$), comparative fit index [CFI] = .99, Tucker-Lewis index [TLI] = .97, root means square error of approximation [RMSEA] = .01; parents' scale: $\chi^2/df = 1.07$ ($p > .05$), CFI = .99, TLI = .99, RMSEA = .01).

Demographics Questionnaires

The collected demographic information included the age and gender of children, family income, and the gender, age, and educational background of their parents/siblings. It also included an item that measured interactive language activities frequency between the child and his or her parent/sibling in the last week (IFE), "What was the language interactive activities frequency between you and your kindergartener child/sibling in the last week?" The parents/siblings were asked to indicate the number of times that they engaged in these activities.

Procedure

Materials and procedures had approval from the Guangzhou Huashang College of human participants' IRB, the Behavioural and Social Sciences Ethical Review Committee under the umbrella project title "Home Literacy Activities and Children Language Development." Our methods likewise fully met international ethical guidelines for research with children (including written parental informed consent coupled with the child's own verbal assent). The participating children and their siblings and parents/guardians signed consent forms before the data collection. The participating families were randomly divided into parent reading (PR) and sibling reading (SR) groups, and each group was further randomly divided into the DR and control (C) conditions. Four conditions were observed, namely, PR-DR, PR-C, SR-DR, and SR-C. Among the 1,030 families who agreed to participate, 180 eventually dropped out from the study. The participants were considered as dropping out from the present study when: (a) the research group lost contact with the participants in the project period; (b) the participants reported they wanted to quit the book reading activities; (c) the participants were forced to stop book reading activities due to medical reasons; or (d) the participants did not attend the posttest session. As a result, 850 families accomplished all given tasks during the intervention. Participating families who completed all assessments and the intervention received a 50 RMB coupon. The PR group included 514 families, whereas the SR group included 336 families. The PR-DR group included 258 ADHD children (128 boys and 130 girls, with $M_{age} = 5.35$ years, $SD = .27$), the PR-C group included 256 ADHD children (126 boys and 130 girls, with $M_{age} = 5.37$ years, $SD = .39$), the SR-DR group included 169 ADHD children (84 boys and 85 girls, with $M_{age} = 5.35$ years, $SD = .20$) and 169 older siblings (63 older brothers and 106 older sisters, with $M_{age} = 12.36$ years, $SD = .48$) who received typical education at Grades 7 or 8 in secondary school, and the SR-C group included 167 ADHD children (84 boys and 83 girls, with $M_{age} = 5.33$ years, $SD = .20$) and 167 older siblings (62 older brothers and 105 older sisters, with $M_{age} = 12.34$ years, $SD = .47$) who received typical education at Grades 7 or 8 in secondary school. Table 1 presents the background information of the participants. The retention rate was high (approximately 82.52%). Moreover, the attrition was unrelated to the variables involved in the study (McKee & Caldarella, 2016), according to a logistic regression analysis of follow up responses versus attrition (Cox and Snell $R^2 < .01$). The attrition sample size did not have a significant statistical effect on the results estimation.

The assessments were carried out in silent classrooms in the schools that the participating children were attending. Children were individually administered tests by trained research assistants in two 30-min sections with a 10-min break in-between. Receptive vocabulary, expressive vocabulary, character reading, morphological awareness, phonological awareness, listening comprehension, nonverbal intelligence, reading interest, and intimacy questionnaires were administered among the ADHD children during the pretest. Meanwhile, nonverbal intelligence, expressive vocabulary, and demographical information questionnaires were administered among the older siblings (in the SR group) and parents (in the PR

Table 1

Demographic Information by Condition

Condition	PR-DR	PR-C	SR-DR	SR-C	ANOVA/t/χ^2
Sample size	258	256	169	167	
Age-ADHD children	5.35 (0.20)	5.37 (0.20)	5.35 (0.20)	5.33 (0.20)	$F(3, 846) = .58, p = .45$
Age-parents/siblings	37.19 (4.54)	37.18 (4.47)	12.36 (0.48)	12.34 (0.47)	SR-DR vs. SR-C: $t = .35, p = .37$
					PR-DR vs. PR-C: $t = .24, p = .62$
Gender composition of parents/siblings	48.83% male, 51.16% female	48.83% male, 51.17% female	37.28% boy, 62.72% girl	37.13% boy, 62.87% girl	SR-DR vs. ST-C: $\chi^2(1) = .03, p = .94$
					PR-DR vs. PR-C: $\chi^2(1) = .01, p = .99$
Nonverbal intelligence-educator of parents/siblings	51.68 (1.86)	51.46 (1.66)	43.46 (4.90)	42.43 (4.70)	SR-DR vs. SR-C: $F(1, 334) = 2.91, p = .11$
					PR-DR vs. PR-C: $F(1, 512) = 1.95, p = .16$
Expressive vocabulary of parents/siblings	54.52 (3.36)	54.46 (3.42)	49.73 (5.52)	49.47 (6.01)	SR-DR vs. SR-C: $F(1, 334) = .17, p = .68$
					PR-DR vs. PR-C: $F(1, 512) = .04, p = .84$
Educator education background of parents/siblings	JS (20.8%) SS (34.7%) U/VC (32.1%) M (11.3%)	JS (20.2%) SS (29.4%) U/VC (35.0%) M (15.4%)	Grade 7 (81.7%) Grade 8 (18.3%)	Grade 7 (80.2%) Grade 8 (19.8%)	SR-DR vs. SR-C: $\chi^2(1) = 1.09, p = .74$ PR-DR vs. PR-C: $\chi^2(3) = 2.55, p = .47$
Children-parents/siblings intimacy	47.43 (4.74)	46.93 (4.63)	47.10 (4.58)	47.57 (4.84)	SR-DR vs. SR-C: $F(1, 334) = .85, p = .36$
					PR-DR vs. PR-C: $F(1, 512) = 1.51, p = .29$
IFE	2.16 (0.93)	2.07 (0.87)	2.12 (0.88)	2.10 (0.90)	SR-DR vs. SR-C: $F(1, 334) = .23, p = .54$
					PR-DR vs. PR-C: $F(1, 512) = .10, p = .75$
Frequency of interactive literacy activities between children and parents/siblings (per week)	0~3 (30.2%) 4~6 (30.2%) 7~10 (33.3%) >10 (6.2%)	0~3 (29.3%) 4~6 (33.6%) 7~10 (33.2%) >10 (3.9%)	0~3 (29.6%) 4~6 (39.1%) 7~10 (26.6%) >10 (4.7%)	0~3 (32.3%) 4~6 (29.3%) 7~10 (34.7%) >10 (3.6%)	SR-DR vs. SR-C: $\chi^2(1) = 4.58, p = .21$ PR-DR vs. PT-C: $\chi^2(3) = 1.83, p = .61$

Note. ANOVA = analysis of variance; ADHD = attention-deficit-hyperactivity disorder; IFE = interactive language activities frequency between ADHD children and parents/siblings in the last week; JS = junior secondary grades; SS = senior secondary grades; U/VC = university/vocational college; M = master or above; PR-DR = parent reading – dialogic reading; PR-C = parent reading – control; SR-DR = sibling reading – dialogic reading; SR-C = sibling reading – control.

group), who were asked to rate their language learning interaction frequency with ADHD children. According to previous studies (e.g., Chow et al., 2021), the intervention length of 12-week is an appropriate duration which balances the duration for detecting children's language changes from the DR intervention and that for feasible implementation. The 12-week intervention started right after the pretest. All families were contacted through phone on a fortnightly basis to ensure that the reading was going smoothly at home. After the 12-week DR intervention, a posttest on the same tasks, except for nonverbal intelligence, was administered among the ADHD children.

DR Condition

Each family was provided 12 narrative story books selected from http://www.qbaobei.com/jiaoyu/jyzy/hb/, which contained many pictures and did not heavily rely on written text. Each of these books contained hints for DR prompt questions. A guideline for implementing the DR technique was also given to the families. The parents/siblings attended a 2-hr workshop where they were trained on how to apply DR methods. In the workshop, the PEER dialogue sequence and CROWD prompts were introduced and explained to the parents/siblings and demonstrations with examples were provided. The storybook "贝贝熊新邻居 (Bear's new neighbors)" was used to elaborate the DR method. First, example prompts and their CROWD type were given. For example, "小熊朋友的名字叫什么? (What is the name of bear's friend?)"—Wh-question'. Then, how the parents/siblings can evaluate, expand, and repeat after PEER sequence was demonstrated. Parents/siblings were asked to try using the DR method to read to the research assistants. The research assistants provided feedback and suggestions accordingly. After the workshop, each parent/sibling participated in a DR practice activity, wherein the researcher played the role of the learner, whereas the parent/sibling applied DR in reading the practice topic "靴子和猫 (boots and cats)." All parents and older siblings demonstrated mastery of DR techniques in the practice activity after the workshop, except two older siblings. These two siblings were provided a further round of training and practice activity, and they demonstrated mastery of DR techniques after this. They read the books with the ADHD children at home for 25 min twice a week for 12 straight weeks by using DR. To efficiently supervise the intervention process, the parents/siblings were required to audio-record every reading session in the 12-week intervention and submit their recordings on Monday to Wednesday (first piece) and Thursday to Saturday (second piece) to the research team. They were also required to record the titles of the books they read and the date and time of each reading session.

Control Condition

The families in the control condition were provided the same reading materials as those used in the DR condition but without the provision of DR prompt question hints and technique guideline. They read these materials with the ADHD children at home for 25 min twice a week for 12 straight weeks. The parents were asked to read the storybooks as they normally would, whereas the siblings were asked to read the storybooks as they or their parents normally would.

Data Analysis

Screen analysis was performed to obtain preliminary statistics for the quantitative data. Chi-square and mixed analysis of variance (ANOVA) tests were performed to examine the baseline differences

in age, gender composition, and language task performances before the intervention. Afterward, a mixed ANOVA test was conducted to examine the teaching effect of older siblings on the development of younger children and to reveal intercondition differences between the pre- and posttests. The effect sizes were measured using eta-squared (η^2), with $\eta^2 = .01, .06,$ and $.14$ indicating small, medium, and large, respectively, following the rule of thumb proposed by Cohen (1988) for effect sizes.

The qualitative data from the DR audio recordings were analyzed via descriptive coding (Saldaña, 2021) and by clustering codes into two themes, namely, typical requirement of DR (e.g., P-E-E-R and C-R-O-W-D) and personal ideas of parents/siblings (e.g., response to the answers of ADHD children; Cahnmann-Taylor et al., 2022). The data were coded by two well-trained research assistant and intercoder reliability test showed a high reliability ($r = .97$) among all audio recordings, indicating that the coding results should be acceptable (Belotto, 2018; O'Connor & Joffe, 2020). The research team supervisor then randomly examined 10 pieces (5 PR-DR and 5 SR-DR) of the coding results by listening to the weekly correspondence records to ensure the coding quality.

Results

Descriptive Analysis and Pretest Measures

In this study, there was missing data in age of two children. We used mean age to make a valid imputation (Tang & Ishwaran, 2017). Table 2 presents detailed information about the task performance of ADHD children and their older siblings or parents. Results of the chi-square and mixed ANOVA tests for ADHD children showed no significant differences in age and gender composition across the PR-DR, PR-C, SR-DR, and SR-C groups ($ps > .10$), in the age, gender composition, nonverbal intelligence,

expressive vocabulary, and education level of parents ($ps > .10$) between the PR-DR and PR-C groups, and in the age, gender composition, nonverbal intelligence, expressive vocabulary, and education level of siblings ($ps > .10$) between the SR-DR and SR-C groups. Meanwhile, results of the skewness and kurtosis analyses revealed that the task performance of ADHD children, siblings, and parents was within ± 2; thereby, indicating the absence of outliers in the study (Hodge & Austin, 2004).

Research Question 1: Does Dialogic Reading With Parents Facilitate the Language Learning of ADHD Children?

A mixed ANOVA test was conducted to compare the changes in language skills and reading interest between the PR-DR and PR-C groups. Control variables included age, gender, and intimacy of ADHD children with their parents, nonverbal intelligence and expressive vocabulary of parents, and the frequency of language interactive activities between parents and ADHD children. Results show that the time effects and Time × Group interaction effects on receptive vocabulary, expressive vocabulary, character reading, morphological awareness, phonological awareness, listening comprehension, and reading interest were significant ($ps < .001$, η^2 range = .30~.81). Meanwhile, results of simple effect analysis showed that PR-DR children demonstrated greater growth in their language skills and reading interest compared with PR-C children ($ps < .001$). According to Cohen (1988), these effect sizes were large.

Research Question 2: Does Dialogic Reading With Siblings Facilitate the Language Learning of ADHD Children?

A mixed ANOVA test was conducted to compare the changes in language skills and reading interest between the SR-DR and

Table 2
Descriptive Statistics of Task Performance in ADHD Children Across Groups

Time & measures	PR-DR		PR-C		SR-DR		SR-C	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pretest								
IQ	12.56	1.74	12.63	1.74	12.52	1.69	12.76	1.66
RV	32.59	1.72	32.61	1.76	32.43	1.87	32.41	1.77
EV	20.12	.92	20.25	.98	20.15	.94	20.24	.92
CR	16.48	1.75	16.49	1.65	16.66	1.74	16.78	1.78
MA	9.19	.92	9.23	.95	9.12	.96	9.19	.90
PA	3.70	.69	3.72	.75	3.67	.72	3.60	.65
LC	2.13	.95	2.19	1.00	2.25	.98	2.23	.98
RI	9.04	.84	9.04	.86	9.07	.84	9.13	.82
Posttest								
RV	39.88	2.42	34.10	.84	40.27	2.37	34.50	.54
EV	23.93	2.35	20.15	.85	29.33	3.07	19.97	.79
CR	25.91	3.06	20.15	2.49	35.87	3.29	20.13	2.68
MA	11.84	1.58	9.49	1.18	14.50	2.07	9.50	1.11
PA	5.86	1.42	3.53	.56	9.01	1.97	3.59	.60
LC	9.41	1.78	3.08	.27	7.01	1.69	3.05	.23
RI	13.45	2.24	10.07	.26	15.70	2.31	10.10	.30

Note. ADHD = attention-deficit-hyperactivity disorder; IQ = nonverbal intelligence; RV = receptive vocabulary; EV = expressive vocabulary; CR = character reading; MA = morphological awareness; PA = phonological awareness; LC = listening comprehension; RI = reading interest; PR-DR = parent reading – dialogic reading; PR-C = parent reading – control; SR-DR = sibling reading – dialogic reading; SR-C = sibling reading – control.

SR-C groups. Control variables included age, gender, and intimacy of ADHD children with their siblings, nonverbal intelligence and expressive vocabulary of siblings, and the frequency of language interactive activities between siblings and ADHD children. Results show that the time effects and Time × Group interaction effects on receptive vocabulary, expressive vocabulary, character reading, morphological awareness, phonological awareness, listening comprehension, and reading interest were significant ($ps < .001$, η^2 range = .63~.91). Meanwhile, in the simple effect analysis, SR-DR children demonstrated greater growth in their language skills and reading interest compared with SR-C children ($ps < .001$). These effect sizes were large (see Table 3).

Research Question 3: Does DR With Parents or With Siblings Yield Similar Effects?

A mixed ANOVA test was performed to compare the changes in the language skills and reading interest development of ADHD children between the PR-DR and SR-DR groups. The same control variables used in the previous analysis were included. Results show that the time effects and Time × Group interaction effects on language skills and reading interest were significant ($ps < .001$, η^2 range = 17~.94). All effect sizes were large, except for the Time × Group interaction effects for receptive vocabulary ($p = .17$, $\eta^2 < .01$), which had a small effect size.

Results of the simple effect analysis showed that SR-DR children demonstrated greater growth in their expressive vocabulary ($M_{diff} = 5.40$, $p < .001$), character reading ($M_{diff} = 9.96$, $p < .001$), morphological awareness ($M_{diff} = 2.67$, $p < .001$), phonological awareness ($M_{diff} = 3.15$, $p < .001$), and reading interest ($M_{diff} = 2.25$, $p < .001$) but lower improvement in their listening comprehension ($M_{diff} = 2.40$, $p < .001$) compared with PR-DR children (see Table 4).

Coding of Qualitative Data Analysis

All families in the DR condition implemented DR twice a week in the 12-week intervention period and audio-recorded each of the sessions. We received 10,248 audio pieces from the DR condition in total. Due to the time constraint, we only used audio recordings ($n = 1,708$) from Week 6 and Week 7 to do qualitative data analysis. We considered Week 6 and Week 7 was a reasonable time as it was in the middle of the intervention period, in which the dyads had become more familiar with the shared reading activities and the interaction in the dyads had become mature after few weeks and

Table 4
Comparison of ADHD Children's Language Abilities and Reading Interest Between SR-DR and PR-DR

Measures	Time effect	η^2	Time × Group	η^2	Comparison
RV	1,246.11***	.60	2.32	<.01	SR = PR
EV	529.27***	.38	83.33***	.09	SR > PR
CR	1,548.80***	.65	118.22***	.12	SR > PR
MA	588.99***	.41	52.96***	.06	SR > PR
PA	484.76***	.36	96.63***	.10	SR > PR
LC	935.39***	.53	29.86***	.03	SR < PR
RI	1,045.55***	.55	30.68***	.04	SR > PR

Note. ADHD = attention-deficit-hyperactivity disorder; RV = receptive vocabulary; EV = expressive vocabulary; CR = character reading; MA = morphological awareness; PA = phonological awareness; LC = listening comprehension; RI = reading interest; PR-DR = parent reading – dialogic reading; PR-C = parent reading – control; SR-DR = sibling reading – dialogic reading; SR-C = sibling reading – control.
*** $p < .001$.

allowing enough time to show any changes in the reading behaviors. Table 5 presents detailed information. According to the audio recordings submitted by parents/siblings in the DR condition, the participants in the SR condition used longer words in their question-and-answer descriptions compared with those in the PR condition. The participants in the SR group also applied more evocative techniques (educator), question by category (educator), interactive frequency, duration for interactive communication, parents/siblings correcting learner behavior, educator question elaboration, educator personal example, positive feedback (educator), typical pronunciation, and response rate to the questions of ADHD children compared with those in the PR condition. However, the participants in the PR condition used more comprehension questions (educator), commenting questions, educator-centered teaching style, and negative feedback to ADHD children compared with those in the SR condition.

Discussion

This pioneering work implemented DR with ADHD children by parents and siblings in a single study, examined the effects of DR on the language learning of Chinese ADHD children, and compared the effects of reading with parents and reading with siblings. Two major findings were obtained. First, DR with parents or siblings enhanced the language development and reading interest of ADHD children. Second, those children who engaged in DR with

Table 3
Time × Group Interaction Effects

Group comparison	RV	EV	CR	MA	PA	LC	RI
PR-DR vs. PR-C							
Difference	597.10***	487.85***	439.97***	225.73***	415.44***	2,138.39***	449.06***
η^2	.54	.49	.46	.31	.45	.81	.47
SR-DR vs. SR-C							
Difference	434.91***	1,262.96***	1,730.67***	566.25***	886.82***	576.63***	798.47***
η^2	.57	.79	.84	.63	.73	.63	.71

Note. RV = receptive vocabulary; EV = expressive vocabulary; CR = character reading; MA = morphological awareness; PA = phonological awareness; LC = listening comprehension; RI = reading interest; PR-DR = parent reading – dialogic reading; PR-C = parent reading – control; SR-DR = sibling reading – dialogic reading; SR-C = sibling reading – control.
*** $p < .001$.

Table 5

Coding of DR Audio Recordings

Coding	Descriptive	PR (N = 258)		SR (N = 169)	
Question description (educator)	Word count in prompt questions (i.e., 这篇故事讲了什么 [what does this story telling about], word count = 8 in this one prompt question)	$M = 20.92$	Range = 4−38	$M = 39.30$	Range = 8−66
	Frequency in total questions (i.e., 小红做什么 [what does Xiaohong contribute], 星期天发生了什么 [what happened on Sunday], frequency = 2 in these two questions)	$M = 25.70$	Range = 13−37	$M = 35.05$	Range = 20−50
Question description (child)	Word count (average) in interactive questions asked by the child (i.e., 这个起飞在文中是什么意思 [what does this word semantic meaning], word count = 12 in that DR activity)	$M = 50.11$	Range = 0−101	$M = 90.80$	Range = 10∼168
	Frequency in interactive questions asked by the child (i.e., 这个词是什么意思 [what does this word semantic meaning], 小明之后会搬回来吗 [If Xiaoming will move back], frequency = 2 in this DR activity)	$M = 5.86$	Range = 0−11	$M = 14.36$	Range = 0−29
Answer Description (child)	Word count (average) in response given by the child (i.e., 星期三 [Wednesday], word count = 3; 是 [Yes], word count = 1, average word count of two responses = 2)	$M = 33.16$	Range = 0−68	$M = 67.63$	Range = 2∼139
Answer Description (educator)	Word count (average) in responses from parents/siblings' feedback/suggestions (i.e., 这个不对 [it is not], word count = 4; 你是对的 [you are right], word count = 4, average word count for these two answers = 4)	$M = 13.37$	Range = 0∼27	$M = 46.54$	Range = 2∼92
Quantity of evocative techniques (educator)	Frequency of CROWD prompt questions ("wh-," and "open-ended" questions, distance questions) per DR Activity (i.e., 这个词是什么意思 [what does this word semantic meaning], 小明之后会搬回来吗 [if Xiaoming will move back], 小明什么时候去的公园 [when did Xiaoming go to park], frequency = 3)	$M = 18.56$	Range = 7−30	$M = 25.54$	Range = 15−37
Quantity of main idea questions (educator)	Quantity of question in main idea question (i.e., What is the story about? What is the main idea of the story? What is its central meaning? Quantity count = 3)	$M = 1.33$	Range = 1−2	$M = 2.96$	Range = 1−5
Interactive frequency	Quantity of interactive communication rounds per DR activity (educators' one question + children's one answer = one round; children's one question + educator's answer = one round)	$M = 14.13$	Range = 5−24	$M = 19.93$	Range = 9−33
Duration of interactive communication	Average length of communication for each prompt question per DR between the educator and child (seconds; i.e., Educator: 这个故事发生地点是哪里 [what does this story telling about], Children: 公园[park], duration = 31 s; Educator: 周三发什么了什么事情 [what happened on Wednesday], Children: 生日会 [birthday party], duration = 29 s, average length of communication for this two prompt question = 30 s)	$M = 76.97$	Range = 35−118	$M = 122.62$	Range = 18−242
Parents/siblings correcting the behavior of learners	Average number of instances wherein the educator corrected the behavior of children (e.g., pronunciation and answer) in a 25-min DR activity (i.e., 是周三 [it is Wednesday], 那个经读jīng [correct pronunciation is /jing 1/], number count plus two for these two correct behaviors)	$M = 8.11$	Range = 0−17	$M = 25.79$	Range = 0−53
Educator question elaboration	Average number of instances where the educator elaborated his/her prompt questions in a 25-min DR activity (i.e., Educator: 问题的意思就是说小明的行为说明了什么问题	$M = 3.19$	Range = 0−7	$M = 5.38$	Range = 0−12

(table continues)

Table 5 (*continued*)

Coding	Descriptive	PR (N = 258)		SR (N = 169)	
	[the question is to ask what does Xiaoming's behavior represent], number count plus one for this elaboration)				
Quantity of comprehension questions (educator)	Quantity of comprehension questions asked to learners in a 25-min DR activity (i.e., 这个故事说明什么问题 [what is the story about?], 小明的行为说明了什么道理 [how can you comprehend Xiaoming's behavior], Comprehension question number = 2 for these two comprehension questions)	$M = 7.08$	Range = 3−11	$M = 4.80$	Range = 3−7
Educator personal example	Quantity of educator's personal example used per DR [i.e., 我小时候会先抓主要时间线索后, 然后做推理 [when I was a child, I usually catch the time cues and then make further inference], number count one for this elaboration)	$M = .86$	Range = 0−2	$M = 3.57$	Range = 0−7
Quantity of commenting questions	Quantity of commenting questions per DR (i.e., 你觉得小明的行为对不对 [how can you find Xiaoming's behavior], number count one for this comment question)	$M = 8.84$	Range = 2−17	$M = 5.58$	Range = 2−9
Teaching style	*Educator centered*: educator fully controlled the topic communication progress and said more knowledge words to learners, educator played a knowledge-base role	$N_{(educator\ centered)} = 106$	Percentage$_{(educator\ centered)} = 41.10\%$	$N_{(educator\ centered)} = 37$	Percentage$_{(educator\ centered)} = 21.9\%$ Percentage$_{(learner\ centered)} = 78.1\%$
	Learner centered: educator assisted learners to continue the conversation, educator played a skilled partner or companion role	$N_{(learner\ centered)} = 152$	Percentage$_{(learner\ centered)} = 58.90\%$	$N_{(learner\ centered)} = 132$	
Response interval (kids)	Response time interval to parents/siblings' interactive questions (second)	$M = 21.28$	Range = 2−40	$M = 6.91$	Range = 2−11
Quantity of positive feedback (educator)	Quantity of parents/siblings' positive tone of louder voice: warm, confirm and support words (e.g., well done, good job) to ADHD kids' answer or suggestions per DR	$M = 6.24$	Range = 0−13	$M = 10.32$	Range = 0−22
Quantity of negative feedback (educator)	Quantity of parents/siblings' negative tone of louder voice: criticism to ADHD kids' answer or suggestions, anger, unfriendly per DR (i.e., 太差劲了 [you are so bad])	$M = 8.03$	Range = 0−17	$M = 3.86$	Range = 0−8
Educator typical pronunciation	Percentage of parents/siblings' pronunciation: typical mandarin, ascent mandarin, dialect	$N_{(typical\ mandarin)} = 93$	Percentage$_{(typical\ mandarin)} = 36.00\%$ Percentage$_{(ascent\ mandarin)} = 41.50\%$ Percentage $_{(dialect)} = 22.50\%$	$N_{(typical\ mandarin)} = 105$	Percentage$_{(typical\ mandarin)} = 62.1\%$ Percentage$_{(ascent\ mandarin)} = 37.9\%$
		$N_{(ascent\ mandarin)} = 107, N_{(dialect)} = 58$		$N_{(ascent\ mandarin)} = 64$	
Response rate (educator)	Parents/siblings response rate to kids' suggestions/questions	$N_{(100\%)} = 90$	Percentage$_{(100\%)} = 34.9\%$ Percentage$_{(90.01\ to\ 99.99\%)} = 30.6\%$ Percentage$_{(80.01\%\ to\ 90.00\%)} = 26.7\%$	$N_{(100\%)} = 145$	Percentage$_{(100\%)} = 85.8\%$ Percentage$_{(90.01\ to\ 99.99\%)} = 14.2\%$
		$N_{(90.01\ to\ 99.99\%)} = 79$	Percentage$_{(lower\ than\ 80.00\%)} = 7.8\%$	$N_{(90.01\ to\ 99.99\%)} = 24$	
Length of the audiotapes	Average length of the audiotapes submit to research team (minute)	$M = 25.59$ min	Range = 23.50−27.58 min	$M = 25.71$ min	Range = 24.01−27.48 min

Note. ADHD = attention-deficit-hyperactive disorder; SR = siblings reading; PR = parents reading; DR = dialogic reading.

their siblings showed greater growth in their expressive vocabulary, character reading, morphological awareness, phonological awareness, and reading interest but less improvement in their listening comprehension compared with those who engaged in DR with their parents.

Effects of DR on the Language Abilities and Reading Interest of ADHD Children

The results of this study are consistent with those of previous research, which showed that home literacy activities, such as book

reading, enhanced the language and reading interest development of ADHD children (Flory et al., 2006; Leonard et al., 2009). This study also extends previous DR research by demonstrating that DR can be successfully implemented to share reading with ADHD children at home. In line with the findings of DR research focusing on typically developing children (e.g., Chow et al., 2018, 2021; Sénéchal, 2017), this study revealed that DR enhanced the language learning and reading interest of ADHD children. Specifically, DR facilitates the interaction and communication between parents/siblings and ADHD children and helps draw the attention of ADHD children during their reading. Interactive communication also helps reduce distractions and maintain the focus of ADHD children during shared reading (Leonard et al., 2009). The ADHD children were encouraged to talk about details of the story and to answer the given questions. Such literacy exposure was positively associated with the language and reading interest development of ADHD children (Leonard et al., 2009).

Reading With Parents Versus Reading With Siblings

Results show that both reading with parents and reading with siblings positively enhanced the effects of DR on the language learning of ADHD children. A further comparison of the DR effects between reading with parents and reading with siblings revealed interesting results. Specifically, ADHD children showed greater improvements in their expressive vocabulary, character reading, morphological awareness, phonological awareness, and reading interest when reading with their siblings than with their parents. These results echo the statement of SLPM (Bandura, 1992) that learning effects are more pronounced in dyads who are less distant in age. Our qualitative data provide some possible explanations for these interesting results. For instance, learner-centered teaching style, evocative techniques, attention to language units, positive feedback, and elaboration of questions given by siblings are likely to facilitate learning engagement and outcomes (Troseth et al., 2020; Xu et al., 2022).

Parents and siblings tended to adopt different teaching approaches in DR. According to the audio recordings, older siblings were more likely to apply a learner-centered teaching style during DR by using friendly, warm, or encouraging words when formulating their questions or by positively responding to the answers of ADHD children to continue their dialogue. By contrast, parents were more likely to apply a teacher-centered style during DR with more directed instruction. Previous studies suggest that children can achieve better learning outcomes when the teaching style adopted in DR is tailored toward their language proficiency level to keep the interaction within their zone of proximal development (e.g., Leonard et al., 2009; Vygotsky, 1978).

Older siblings also applied more evocative techniques (i.e., asking more "wh-" and "open-ended" questions, pointing requests, and linking something that has already occurred in the story to new information in an effort to maintain coherence) during DR compared with parents. Evocative techniques can increase the attention of ADHD children toward the dialogue and further improve their language learning outcomes. The interactive questions asked by older siblings to ADHD children focused on the knowledge level and skills of learners and were constructed using words that children can easily understand. According to the audio recordings, those ADHD children who read with their older siblings used a greater variety of words when answering questions

compared with those who read with their parents. Moreover, older siblings paid more attention to individual units of language (e.g., word reading accuracy) compared with parents. Specifically, compared with parents, older siblings used typical standardized Mandarin more often when offering suggestions and correcting the word pronunciation of ADHD children, which facilitated the character reading, phonological awareness, or expressive vocabulary learning of ADHD children.

The learning improvements of ADHD children attributable to their DR with older siblings may also be ascribed to the positive feedback offered by the siblings to their answers/questions and their elaboration of their questions. Compared with parents, these older siblings were more likely to respond positively (e.g., using positive or encouraging words, such as "well done" and "'exactly") to the answers of ADHD children. For example, 85% of older siblings provided feedback on all responses given by the ADHD children, whereas only 35% of the parents provided feedback.

In the comparison of results between parent and sibling DR, ADHD children showed greater growth in their listening comprehension when they read with their parents than with their siblings, which may be attributed to the types of questions asked by their parents. According to the audio recordings, parents were more likely to ask comprehension questions (e.g., sentence or story comprehension questions) to ADHD children. As a result, ADHD children received more language comprehension practice in DR when learning with their parents than with their older siblings. While the word-level skills of ADHD children improved when reading with their siblings, listening comprehension is not a word-level skill that requires an understanding of more complex structures and higher-level skills. Therefore, reading with parents is more likely to enhance the higher-level language skills of children. Future studies may investigate the differences between the influences of parent reading and sibling reading and their mechanisms.

Implications, Limitations, and Future Directions

Theoretically, this study provides new empirical evidence regarding the positive impacts of DR and reading with older siblings on the language and reading interest development of kindergarten ADHD children. In terms of practical significance, this study informs parents and educators about some methods that can contribute to the language and reading interest development of ADHD children. These methods are particularly important as they effectively involve older siblings in the language learning of ADHD children. The siblings of junior secondary grade children with no background in psychology or linguistics can master and use the DR technique in the storybook reading context.

This study has several limitations. First, this study did not specify the language proficiency of ADHD children, whereas previous studies find that those children who have lower language proficiency may benefit from DR more than other children (Xu et al., 2022). Therefore, the effect of DR on ADHD children with different language proficiency levels requires further exploration. Second, the parents/siblings involved in this study had no special educational needs. Previous studies show that parents/siblings with behavioral problems positively affect the teaching and learning of children (e.g., Molinaro et al., 2020). Therefore, future studies should further explore the possible effect of those parents/siblings who have special educational needs on the language and

reading interest development of ADHD children during DR activities. Third, the audio recordings from the control group were not analyzed. Therefore, we do not know whether the control group was an "active" or "passive" control group because there is not any information about what these families did during the at-home reading sessions. Lastly, this study examined the effectiveness of DR by comparing the DR and the control conditions. Further studies could investigate the contribution of the DR intervention factors to ADHD children's language skills. For example, these studies could examine whether ADHD children who experience more or specific DR strategies from parents/siblings have more language gains in the DR group.

Conclusion

This study extends past research by examining the effects of DR delivered by parents or older siblings on the language skills and reading interest of ADHD kindergarten children. Results suggest that both parents and siblings play an important role in fostering the language development of ADHD children, demonstrate the feasibility of engaging ADHD children in DR by their older siblings, and highlight the importance of involving siblings in home literacy activities to facilitate the language development of ADHD children.

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