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Helping parents enhance vocabulary development in preschool children: Effects of a family literacy program

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ABSTRACT

Family literacy programs seek to improve a wide range of developmental aspects, of which an important one is how parents develop their children's vocabulary. The effects of these programs are limited, partly because they appear to give insufficient guidance and support to parents in changing how they interact with their children. To increase the impact of family literacy programs, two ways to support parents in changing their interaction behavior were examined: active learning during parent group meetings (AL) and technology-enhanced learning with real-time interaction support (TL). The effects on vocabulary were investigated in children involved in preschool education programs. In an experimental design with partially randomized clusters, 223 preschool children were enrolled in a family literacy program with AL, TL or in the control condition without a family literacy program. Results showed that children in the AL condition made larger receptive vocabulary gains than control children, whereas TL children showed similar gains to controls. Children in all three conditions made similar gains in productive vocabulary. These results demonstrate the strength of AL and shows the complexity of implementing TL.

Early vocabulary is a powerful predictor of reading and writing proficiency and is related to a successful school career (Dickinson, Griffith, Michnick Golinkoff, & Hirsh-Pasek, 2012; Torppa et al., 2007). Vocabulary development in preschool children is largely determined by social interactions during parent-child activities in the home environment (Hoff, 2003; Rowe, 2012). Family literacy programs seek to enhance children's vocabulary development by training parents' interaction behavior and providing language stimulating activities to be conducted at home (Sénéchal & Young, 2008). Yet these programs yield only limited effects, probably because they seem to provide insufficient support to parents in changing their interaction behavior at home (Blok, Fukkink, Gebhardt, & Leseman, 2005; Grindal et al., 2016; McElvany & Artelt, 2009; Van Steensel, McElvany, Kurvers, & Herppich, 2011). In this study, we examined two ways of supporting parents' interaction behavior with the aim of increasing the impact of family literacy programs: active lerning during parent group meetings (AL) and technology-enhanced learning with real-time interaction support (TL). In a large-scale intervention study with Dutch children involved in preschool education programs, we examined the potential benefits of a family literacy program including AL or TL for vocabulary development.

Parent–child interaction is considered to be a key factor in the vocabulary development of preschool children (Hoff, 2003). Two aspects of parent–child interaction have been found to relate to children's vocabulary development: the amount of high quality linguistic input and the degree of sensitive responsiveness. Linguistic input is of high quality when parents provide diverse and sophisticated vocabulary (Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010), open-ended questions (Mol, Bus, de Jong, & Smeets, 2008) and decontextualized language beyond the here and now (Hoff & Naigles, 2002; Kleeck, 2008). Children who engage in frequent high quality interactions with their parents have larger vocabularies and develop vocabulary at a faster rate than children who are involved in fewer and lower quality interactions (Hoff, 2003; Rowe, 2012).

The extent to which parents adjust linguistic input to their child's cognitive and emotional needs is essential for fostering children's vocabulary development (Landry, Smith, & Swank, 2006). In attachment theory this is referred to as sensitive responsiveness (Ainsworth, Blehar, Waters, & Wall, 1978). Recognizing

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children's needs and providing contingent behavior contributes to secure parent–child attachment which is considered the basis for parent–child interaction. Providing emotional support (i.e., warmth, acceptance and encouragement; Landry et al., 2006), respecting children's autonomy by treating them as unique individuals (Erikson, 1950), and structuring and limiting settings by providing clear expectations of children's behavior are prerequisites in this respect (Thompson, 1998). These parent behaviors contribute to a safe, consistent and stimulating home environment in which young children can develop their social and cognitive abilities.

One way to increase children's vocabulary is by supporting parents. Family literacy programs aim to train parents how to interact with their children and provide stimulating parent-child activities (such as story books, craft materials, games) to be conducted at home (Sénéchal & Young, 2008). These programs can be defined as 'programs to teach literacy that acknowledge and make use of learner's family relationships and engagement in family literacy practices' (Hannon, 2003, p.100). By focusing on the way parents interact with their children, family literacy programs aim to make permanent, positive changes in the routines of family life and aim to promote long-term vocabulary development (McElvany & Artelt, 2009; Van Steensel et al., 2011).

Several meta-analyses on the effects of family literacy programs on vocabulary have been conducted, both as stand-alone programs and in combination with preschool programs. Blok et al. (2005) focused on the effects of combined and stand-alone family and preschool programs. They found a moderate overall effect size of both program types (Cohen's $d = 0.32$), whereas combined family literacy and preschool programs were 0.5 SD more effective than stand-alone family literacy programs (Blok et al., 2005). They also found that programs including coaching of parenting behavior were positively related to outcomes in the cognitive domain. Van Steensel et al. (2011) focused on the effects of stand-alone family literacy programs and examined whether certain program characteristics, including combining a family literacy program with a preschool program, moderated vocabulary effects. They found a small overall effect of family literacy programs (Cohen's $d = 0.18$). No moderator effect was found for family literacy programs combined with preschool programs. In a more recent meta-analysis, Grindal et al. (2016) examined the effects of combined family literacy and preschool programs on children's cognitive and pre-academic skills and found no effects of family literacy programs in addition to preschool programs. However, they did find suggestive evidence ($p < .10$) that family literacy programs in which interaction behavior was systematically modeled and practiced with parents was associated with greater effects on children's pre-academic skills (such as reading, counting and letter recognition).

Most studies included in these meta-analyses were based on effects on general receptive vocabulary tasks that did not relate to program content, as opposed to curriculum-based tasks that measure program-specific vocabulary. Curriculum-based tasks provide insight into the learning process within the program, whereas general vocabulary tasks demonstrate the transfer of this knowledge to vocabulary outside the program context (Espin, Shin, & Busch, 2005). Moreover, vocabulary knowledge exists in a continuum in which receptive knowledge (understanding words) can be seen as a precursor to productive knowledge (actively using words) (Nagy & Scott, 2000). Possibly, the effects of family literacy programs on vocabulary growth are underestimated by the use of general receptive vocabulary tasks. Acknowledging the methodological advances of standardized vocabulary tests, effects of family literacy programs could be identified in more detail when measured using receptive and productive curriculum-specific and standardized vocabulary tests.

Overall, the meta-analyses demonstrate positive vocabulary effects from family literacy programs, particularly when parents receive intensive training and coaching, although their impact appears limited. Researchers argue that these small effects may be due to insufficient guidance and support of parents in the programs (Grindal et al., 2016; McElvany & Artelt, 2009; Van Steensel et al., 2011). The approaches most family literacy programs use to change interaction behavior may be insufficient to produce significant changes that are sustained in daily interactions at home (Grindal et al., 2016). Parents are often trained in parent group meetings during which they are provided with information about parenting or child development. These meetings tend to focus on general parenting topics and provide limited active learning opportunities for parents to experience and practice the targeted interaction behavior. Moreover, parent meetings are often conducted by paraprofessional volunteers who have limited theoretical background knowledge (Van Steensel et al., 2011). Video observation of parent-child interactions has demonstrated that, as a result, parents were not able to give high quality linguistic input and to be sensitive responsive at home because the structure of parent-child conversations, the quantity of parental feedback, and the extent of parental guidance were unsatisfactory (McElvany & van Steensel, 2009). Following Van Steensel et al. (2011), we can conclude that, if parental support is not optimal, program implementation in the homes is likely to be limited, which limits the added value of family literacy programs for children's vocabulary development.

One way to optimize parental support, is by engaging parents in active learning activities (Kaminski, Valle, Filene, & Boyle, 2008). Active learning can be defined as 'involving students [parents] in doing things and thinking about what they are doing' (Bonwell & Eison, 1991, p. 19). In contrast to passively listening to information provided by teachers, active learning stimulates parents and engages them in higher-order thinking about their own behavior (Kaminski et al., 2008). Active learning activities include modeling, opportunities to practice, and interactive discussions to evaluate interaction behavior. Observing teachers modeling interaction behavior (such as interactive story-book reading with open-ended questions) allows parents to create a mental representation of the proposed behavior (Bandura, 1971). Retention of this behavior can then be supported when the observed behavior is brought into practice, for example by pretend play and role play, and evaluated in interactive discussions. Modeling high quality and sensitive responsive interactions and providing opportunities to practice, is more likely to increase this behavior in parents and therefore children's vocabulary development, compared to passive learning (Grindal et al., 2016).

When implementing active learning activities in parent group meetings, one should be aware of challenges, both for the teacher and parent (Bonwell & Eison, 1991). Active learning activities require highly developed teacher skills, such as being a role model, stimulating parents and creating a comfortable and safe atmosphere for activities to take place. For parents who are familiar with a more passive listening role, active learning might be strange and out of their comfort zone. Moreover, parents have to transfer the acquired interaction behavior to at-home activities with their child. Therefore, teachers should be extensively trained in creating a safe and participatory learning environment for active learning to be effective, including transfer of interaction behavior to the home environment.

An alternative way to support parent's interaction behavior and to stimulate this behavior taking place in the home environment is by using technology-enhanced learning that provides real-time interaction support. Recent studies have shown that technology-supported literacy activities, such as technology-enhanced storytelling, can foster parent-child interaction and children's vocabulary development (Gremmen, Molenaar, & Teepe, 2016; Teepe, Molenaar, & Verhoeven, 2017). Technology-enhanced storytelling includes real-time visual, auditory and textual interaction prompts and can generate high-interaction quality including decontextualized language beyond the here and now (Teepe et al., 2016). One of the advantages of technology-enhanced storytelling is that, as opposed to Active learning (AL), it requires no transfer of interaction behavior learned in a parent meeting to the home environment. As parents receive real-time interaction support, this type of activity may facilitate sustained changes in parents' interaction behavior in the home. Within the family literacy program, technology-enhanced storytelling can be used as an activity to model the proposed interaction behavior and to transfer this behavior to other program activities (i.e., shared reading). It should, however, be implemented with caution, as implementation of technology-enhanced learning seems to depend largely on both the teacher's and parent's computer skills, their attitudes towards technology-enhanced learning such as technological self-efficacy, and the teacher's technological pedagogical knowledge (Marakas, Yi, & Johnson, 1998; Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013). Therefore, it is important that teachers are trained and that parents are intensively guided in their use of technology-enhanced learning activities at home.

1. Present study

One of the major challenges is to support parents in such a way that high quality and sensitive responsive input are sustained in daily home interactions. In this study, an effort has been made to examine the effects of a Dutch family literacy program with active learning (AL) and technology-enhanced learning (TL) on children's vocabulary development. In the AL condition, parents were involved in parent meetings that included modeling, role play and interactive discussions. In the TL condition, the focus of the parent meetings was on technology-enhanced storytelling with real-time interaction support. AL and TL children were compared to a control condition consisting of children involved in a preschool program. The main research question was: what is the effect of a family literacy program including active learning or technology-enhanced learning on general and curriculum-based vocabulary development of preschool children? The effects of AL and TL were investigated combined with a preschool program and determined with multiple vocabulary tasks (i.e., curriculum-based receptive and productive, and general).

2. Method

2.1. Sample and design

The present study is part of //author identifying information removed// (see also //author identifying information removed//) in the Netherlands. Dutch preschool organizations were approached to participate along with their preschools. Preschools were included if they met all Dutch policy quality standards for preschool education (i.e., a maximum class size of 16 children, child-to-teacher ratio of 16:2, a qualified center-based program and preschool teachers who have received specialized center-based training). Moreover, preschools were only included if the teachers had no prior professional experience with a family literacy program. Thirteen preschools (two to six per preschool organization) met the inclusion criteria and were willing to participate.

Because of policy constraints, we used an experimental design with partially randomized clusters to allocate preschools to the AL, TL or control condition. Four preschools were required by their local policy to start with a family literacy program that particular school year and were randomly assigned to AL or TL. The remaining nine preschools were randomly assigned to one of three conditions. This resulted in four AL preschools ($n = 72$ children at the start of the project), four TL preschools ($n = 73$) and five preschools participating as a control group ($n = 78$). Participating preschools had, on average, 17 parent–child dyads, ranging from eight to 30 dyads.

Preschool teachers recruited families via a brochure and introductory meeting. The age inclusion range for the children was 30–39 months (2.6–3.3 years of age), following program guidelines and taking into account that children older than 39 months would enter formal schooling before the end of the study. A total of 223 preschool children ($M_{age} = 35.4$ months, $SD_{age} = 3.5$ months) started the study, of whom 43.5% ($n = 97$) were girls. Following the standard procedure in Dutch preschool education, all children attended the preschool two to four half-days (6–12 h) per week.

Children came from linguistically diverse backgrounds. In 108 families (48.4%) only Dutch was spoken at home with these children learning Dutch as a first language (L1). In the other families ($n = 115$) either a combination of Dutch with other language(s) or only other language(s) were spoken at home (with a total of 48 different languages including Moroccan, Turkish, Polish, Farsi, Papiamento). These children learned Dutch as a second language (L2). The ratio of L1/L2 children within preschools varied from 20.0% to 94.4% L2 children. Of 223 participating parents, 86.1% were mothers. The highest education level of the mother was used as a measure for educational level, based on maternal education being the most robust sociodemographic predictor of child development (Bornstein, Hahn, Suwalsky, & Haynes, 2003). Educational level was measured on a six-point-scale ranging from no education (1) to university (6) and showed a mean of 4.4 ($SD = 1.2$). There was a small bias because for one preschool (n = 18 children), the percentage of lower educated mothers was fairly high (33.3%), whereas for three other preschools (n = 18 to 25 children) the percentage of higher educated mothers was high (60% to 76.2%). Linguistic diversity and mother's educational level were included as covariates.

The study involved 46 female preschool teachers with two to four teachers per preschool. The high ratio of teachers to preschools ($N = 13$) is due to governmental guidelines stipulating a 16:2 child-to-teacher ratio as well as to most teachers working part-time. Teachers' ages ranged from 27 to 60 ($M = 47.38$, $SD = 7.95$ years). The majority of teachers (37, 80.4%) teachers completed vocational education, eight higher professional education (17.4%) and one university education (2.2%). All teachers were experienced professionals with over five years of work experience. Differences across conditions on participant characteristics are presented in the results section after taking into account attrition.

2.2. Intervention

The family literacy program used in the current study was the Dutch program 'Early Education at Home' (In Dutch: VVE Thuis, developed by the Dutch Youth Institute, 2014). The key element of the program was to improve linguistic input quality and sensitive responsiveness. To achieve this, the program classified theoretical elements of linguistic input quality and sensitive responsiveness (Ainsworth et al., 1978; Hoff, 2003) into five general guidelines for parent-child interaction. These guidelines were (1) involve your child in conversations, (2) encourage your child, (3) provide rules and structure, (4) recognize your child's needs, (5) provide autonomy. The general guidelines were used to provide practical examples of specific interaction behavior during the parent meetings. Every six weeks parents received a workbook with eight activities to be conducted at home (i.e., shared reading, storytelling activities, memory games, puzzles, songs and rhymes, arts and craft activities, and daily activities). During 1.5-h parent group meetings, parents were trained on interaction behavior to be performed during these activities. Parent groups consisted of, on average, 12 parents (ranging from 6 to 25 parents, with the larger groups being divided into subgroups during the meeting) to allow active group interactions. The program was aligned with the preschool program, with the same four six-weekly themes and content offered at the same time.

2.3. Active learning during group meetings (AL)

Teachers were familiarized with the family literacy program, including AL, via an information session (2 h), training session (4 h) and two 1-h coaching sessions after the first two parent meetings (all provided by the first author). The focus of the AL training and coaching was on active learning activities to be conducted with parents. We trained teachers how to model, practice and interactively discuss the activities and proposed interaction behavior. During the training, teachers evaluated video examples of parent–child interactions, practiced with modeling activities (for example shared reading), and conducted interactive discussions about program materials and interaction behavior. In addition, teachers were informed how to create a safe and active learning environment. In the coaching sessions, the first author provided feedback on the active learning activities used by the teacher during the parent group meeting.

In the parent group meetings, teachers were requested to start by evaluating the preschool and family literacy program activities from the preceding theme. They had to interactively discuss how activities had been conducted, what parents had learned from it and what difficulties they had experienced. The focus of this evaluation was on parents' ability to apply the five general interaction guidelines at home. We suggested that teachers next introduced the new theme. They were asked to go through all the activities of the programs' workbook by using modeling techniques, role play, conducting activities together and interactively discussing activities. Again, teachers were asked to focus on parents' interaction behavior during these activities. In addition, we invited teachers to show concrete preschool materials (books, toys, games) to explain parallels between the preschool and family literacy program.

2.4. Technology-enhanced learning (TL)

TL teachers were, as with AL teachers, familiarized with the family literacy program and TL via an information session (2 h), a training session (4 h) and two 1-h coaching sessions after the first two parent meetings. The focus of the TL training and coaching was to make teachers familiar with the tablet computer and the technology-enhanced storytelling activity Jeffy's Journey. Jeffy's Journey was a digitized version of one of the program activities. It involved shared verbal storytelling supported by a story structure and real-time visual, auditory and textual prompts (//author identifying information removed//). It consisted of four storytelling phases that guided parent and child through creating a meaningful story together. For each character in the story, they could select visual, auditory and textual storytelling prompts, such as emotion changes and open-ended questions. There was also a digital instruction available with screenshots of the activity and audio instruction. We trained teachers how to conduct technology-enhanced storytelling, how to explain the concept to parents and how to facilitate transfer of the interaction behavior to other program activities. During the training, teachers were told about the functions of the tablet computer, practiced technology-enhanced storytelling, and conducted an interactive discussion on interaction behavior during technology-enhanced storytelling. During the coaching sessions the first author provided feedback on the delivery of technology-enhanced storytelling by the teacher during the parent group meeting.

In the parent groups meetings, teachers were instructed to first evaluate the preschool and family literacy program activities of the preceding theme. They had to interactively discuss how technology-enhanced storytelling and program activities had been conducted, what parents had learned from it and what difficulties they had experienced. We advised teachers to focus on parents' ability to apply interaction behavior during technology-enhanced storytelling and the transfer of this behavior to other program activities. Next, teachers were asked to introduce the new theme. They introduced the technology-enhanced storytelling activity and had to discuss with parents how to use the same interaction behavior during other program activities. In addition, we asked teachers to show concrete preschool materials (books, toys, games) to explain parallels between the preschool and family literacy program. TL parents received a tablet computer (on loan) pre-loaded with Jeffy's Journey.

2.5. Treatment fidelity

To ensure the two groups of AL and TL teachers provided the same instruction during parent meetings they were provided with a manual containing a protocol explaining step-by-step what to address during each parent meeting and how to do it. In addition, three measures were used to assure treatment fidelity. In the first place, preschool teachers registered parent's presence at the four parent meetings. Parents who were not able to attend the meeting and instead received individual instruction were included as present. Second, participating parents were asked to record their program activities in a diary, with one diary per theme. Diaries were handed in at the end of each theme. The total number of diaries handed in was counted, ranging from 0 to 4. As a final measure of treatment fidelity, the number of program activities conducted in the course of the school year was calculated from the diaries.

2.6. Measures

2.6.1. Vocabulary

Children's vocabulary development was assessed by means of three vocabulary tasks: a receptive and a productive curriculum-based vocabulary task and a general vocabulary task. The curriculum-based vocabulary tasks were designed to assess vocabulary in the four themes offered during the intervention period. From each of the four themes six words (nouns, verbs and adjectives) were selected with a total of 24 words. These words were comparable in their frequency in the program materials and suited the target group according to a Dutch wordlist for preschool children (Bacchini, Boland, Hulsbeek, & Smits, 2005). The 24 words were assessed in a productive and in a receptive vocabulary task (the former before the latter) that consisted of the same words. In the productive task, children were shown a picture of the target word and simultaneously asked to complete a sentence in which the target word was left out (for example: The dog wags his ... [tail]?). For each correctly completed sentence, one point was assigned with a maximum of 24 points (Cronbach's α for pre- and post-test were .85 and .86). All responses other than the target word, including responses in other languages, were assigned a zero score. The receptive task followed the format of the Peabody Picture Vocabulary Test in which children had to select the picture of the target word from among three distracters (perceptual, phonological and semantic). Each correctly selected item was assigned one point, with a maximum of 24 points (Cronbach's α for pre- and post-test were .79 and .84).

General receptive vocabulary was assessed by the Dutch version of the Peabody Picture Vocabulary Test (PPVT-III-NL, Dunn & Dunn, 2005). In the PPVT, the child was orally presented one target word at a time. Out of four pictures he/she had to select the picture corresponding to the target word. The test was finished when the child gave nine or more incorrect responses within a set of 12 items. Each item was scored as one point, with a maximum of 175 points. Reported reliability (lambda-2-coëfficient) was excellent: between .89 and .90 for children of 2;3 to 3;5 years of age (Schlichting and Lutje Spelberg, 2010).

2.7. Covariates

Previous research (//author identifying information removed//, Van Druten-Frietman, Denessen, Gijsel, & Verhoeven, 2015) emphasized the role of certain child and family factors in explaining vocabulary. Children's age, gender, executive functioning and social functioning influence parent–child interaction and vocabulary development, as do linguistic diversity and educational level of the mother. Therefore, these factors were included in our models as control variables.

2.7.1. Executive functioning (EF)

In line with previous research into preschool children's EF (Wiebe et al., 2011; Weiland, Barata, & Yoshikawa, 2014), the EF concept was operationalized with multiple tasks measuring different dimensions that cluster into a unitary EF construct. Each task relied on a different but related EF component; a word repetition-string task measured working memory (Schlichting & Lutje Spelberg, 2010), the Hand Game (Hughes, 1996) measured response inhibition and the Dimension Change Card Sort measured attention shifting (DCCS, Zelazo, 2006). All tasks showed high internal consistency (Cronbach's $\alpha = .90$, $\alpha = .81$ and $\alpha = .73$ respectively). A Principal Component Analysis with Varimax Rotation showed one underlying factor with an eigenvalue >1, explaining 42.6% of the total variance. Component loadings were .57 (working memory), .74 (response inhibition) and .64 (attention shifting). The composite score was calculated by adding up the z-score of the working memory task and the dichotomous scores of response inhibition and attention shifting. This was then divided by the number of tasks ((z-memory + response inhibition + attention shifting) / 3).

2.7.2. Social functioning (SF)

Children's social functioning was measured by a subset of the Dutch KIJK! observation scale for preschool children (van den Bosch & Duvekot-Bimmel, 2012), which was completed by preschool teachers. There were fifteen statements about how children behave with respect to peers and teachers (for example, 'the child is able to share with other children'). Items were scored on a 3-point-scale including 'not observed', 'partly observed' and 'entirely observed'. Internal consistency was high (Cronbach's $\alpha = .90$). This is in line with the validated kindergarten version (van den Bosch & de Jaeger, 2000). Calculations were conducted on the mean score.

2.7.3. Background variables

Parents received a background questionnaire containing questions about their child (gender and date of birth) and about themselves (their educational level and language(s) spoken at home). Teachers also received a questionnaire with questions about their age, educational level and years of working experience.

2.8. Procedure

An overview of the study's procedure is provided in Fig. 1. The study took place from August 2014 to May 2015. In August, all teachers were provided an information session. At start of the school year, in September 2014, AL and TL teachers received their training, and information sessions for parents (AL, TL and control) were organized to tell them about the study and to ask them to participate. Before the start of the study, teachers gave active consent for their participation as did parents for their child's and their own participation.

The pre-test was performed in September 2014, when the majority of children had just entered preschool. Vocabulary and executive functioning tasks were administered in two separate sessions. Children were individually tested in a quiet place outside the classroom. They were tested by eight trained test-assistants who followed strict testing protocols. At the time of testing, parents and teachers completed the questionnaires. Over the course of the school year, all children (AL, TL and control) participated in the same four six-weekly themes of the preschool program: Me and my family, Winter, Clothes and Spring. At the same time, AL and TL children and their parents were involved in the same four themes at home via the family literacy program. The testing procedure of pre-test was repeated at the end of the school year by the same test-assistants (May 2015). The study was approved by //author identifying information removed// (dossier: //author identifying information removed//).

2.9. Analyses

We estimated, a priori, that a sample of 192 children (3 conditions * 64 children) was adequate to test the effect of our interventions with a two-sided test, an alpha of .05 and a statistical power of $\beta = .80$, assuming a medium experimental effect (Cohen's $d = 0.50$). This effect size was based on previous studies on family literacy program effects (Lonigan, Escamilla, & Strickland, 2008; Mol et al., 2008; Van Tuijl, Leseman, & Rispens, 2001).

Attrition analysis showed that some children entered formal schooling earlier than expected because the children missing at the post-test ($n = 35$) were not missing at random, but were significantly older than children who participated in all tests ($t(188) = -2.1$, $p = .044$). These children did not differ in other demographic variables. Of 223 cases, 89 cases were incomplete because of missing values within a test or questionnaire ($n = 34$), children not being present during test administration ($n = 8$) or children being distressed during test administration ($n = 12$). Demographic data on the child (age, gender) and parent (educational level mother, linguistic diversity) was complete. To prevent information loss, missing data within tests and questionnaires was imputed at item level using Expected Maximization in SPSS 22 (IBM Corp, 2013). Missing data on entire tests or questionnaires was not imputed. As a result, 34 of 89 cases (38.2%) with missing values could be included in the analysis resulting in a total of 168 cases. Of these children, 54 were in the AL condition, 48 the TL condition and 66 the control condition (see also Fig. 1).

A multilevel regression analysis was conducted to account for the hierarchical structure of the data (children nested in preschools). Analyses were performed in MLwiN 2.35 (Rasbash, Steele, Browne, & Goldstein, 2009). Even though the intra-class correlation for the three dependent variables was small ($\rho = .03–.05$), Kreft and De Leeuw (1998) demonstrated that even small values may inflate the alpha level resulting in an increased chance of a Type I error.

Models were constructed for each of the dependent variables using the same modeling procedure. We first entered the grand mean-centered pre-test scores (Hox, 2010; Snijders & Bosker, 1999). Second, we determined treatment fidelity and tested whether treatment fidelity of the AL and TL conditions (diaries handed in and presence at parent meetings) were related to program effects. In the third model, the experimental condition was entered. Finally, interactions between treatment fidelity and vocabulary measures variables were included, to evaluate whether the effect of treatment fidelity differed per condition.

Next, we tested whether AL and TL had an effect on vocabulary development, including all conditions. We first entered the

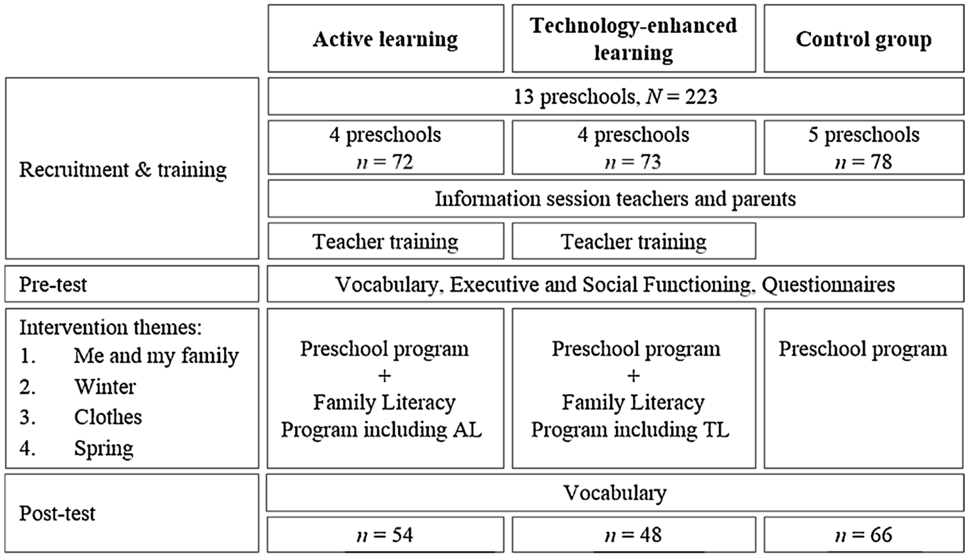

Fig. 1. Study overview with timeline for AL, TL and control condition.

pre-test. In the second model, control variables at child level were included: children's age, gender, executive functioning, social functioning, and linguistic diversity and mother's educational level. In the third model, the independent variable condition was entered. Condition was included as a categorical variable (AL = 1, TL = 2) with the control group as reference category (= 0). Teacher variables were available on preschool level (N = 13) and due to the limited number of cases at this level, these could not be included in the models. Effect sizes (Cohen's d) were based on the final models including all covariates.

3. Results

3.1. Treatment fidelity

Overall, parents attended on average 2.82 (SD = 1.36) of four parent meetings. Almost half of the parents, 46.1% (n = 47) attended all four meetings, but 9.8% (n = 10) attended none. Parents returned on average 2.44 (SD = 1.56) of four diaries. Of all parents, 34.3% (n = 35) returned all four diaries and 22.5% (n = 23) returned none. The quality of implementation can therefore be considered reasonable. Multilevel logistic regression analysis with Poisson distribution for count data (Kreft & De Leeuw, 1998) showed that parents in the TL condition attended significantly more parent meetings (M = 3.33, SD = 1.18) than parents in the AL condition (M = 2.37, SD = 1.34), (B = .341, SE = .118, p = .004). AL parents (M = 2.56, SD = 1.47) and TL parents (M = 2.31, SD = 1.66) returned similar numbers of diaries, (B = −.098, SE = .153, p = .522). Because of the relatively low diary return rate (34.3% returned all four diaries), the number of literacy activities conducted over the school year could not be computed and was therefore not included in further analyses. Bivariate correlations (see Appendix A) show that presence at parent meetings and the number of diaries handed in were strongly associated (r = .70, p < .001). Further, there was a small negative association between presence at parent meetings and linguistic diversity at home, with the parents of L2 children attending less parent meetings (r = −.20, p = .010).

Table 1 shows that there was no effect of treatment fidelity on receptive, productive or general vocabulary. Both the number of diaries handed in and the number of parent meetings attended did not predict children's vocabulary scores. In other words, the variation in treatment fidelity did not moderate AL or TL effects. Interaction variables (condition*diaries handed in and condition*presence parent meetings) showed no influence of treatment fidelity within the two conditions either. Thus, treatment fidelity did not moderate condition effects.

3.2. Descriptive statistics for AL and TL

Table 2 presents descriptive statistics for vocabulary tasks (unadjusted by covariates) and covariates. The large standard deviations on the vocabulary tasks reflect the heterogeneity (i.e., varying linguistic background and educational levels of the mothers) of the sample. A preliminary analysis on the vocabulary pre-tests and covariates showed that children in the AL condition were slightly older than children in the control condition (B = 1.407, SE = 0.571, p = .014) and TL condition (B = 1.324, SE = 0.617, p = .032): these variables have been included as covariates in the final model. Children from different conditions did not significantly differ on vocabulary pre-test scores or on other covariates. Bivariate correlations (Appendix A) showed that the strongest associations exist between the vocabulary pre- and post-tests (r = .55 to r = .80, p < .001). Moreover, the control variables executive functioning, social functioning and linguistic diversity were associated with vocabulary scores (r = .33 to r = .57, p < .001).

3.3. Vocabulary effects of AL and TL

Final multilevel models for the three outcome variables receptive, productive and general vocabulary are presented in Table 3. The covariates included in Model 2 significantly improved the fit of the model (Δ-2LL = 25.149, df = 6,

p < .001) and explained an additional 6% of the variance. Linguistic diversity was related to receptive vocabulary, with L1 children having higher receptive vocabulary scores. The other covariates were not related to receptive vocabulary. In the final model, condition was included. The resulting Model 3 had a significantly better fit than Model 2 (Δ-2LL = 6.631, df = 2, p = .036). There was an effect of condition, with children in the AL condition showing higher receptive vocabulary post-test scores compared to the control group (B = 1.879, SE = 0.747, p = .012). The size of this effect was moderate (Cohen's d = 0.39). The TL condition did not differ from the control condition (B = 0.118, SE = 0.741, p = .112, Cohens d = 0.02). The final model explained 45% of the variance.

For productive vocabulary, including the covariates significantly improved model fit (Δ-2LL = 17.577, df = 6, p = .009). Linguistic

Table 1
Effects of treatment fidelity for the AL and TL condition ($n = 102$).

	Receptive vocabulary		Productive vocabulary		General vocabulary	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Fixed model						
Intercept	15.973	1.463	9.058	1.113	44.531	3.958
Pre-test	0.615**	0.088	0.897**	0.071	0.618**	0.070
Treatment fidelity						
Diaries handed in	0.249	0.417	0.318	0.311	0.248	1.165
Presence parent meetings	−0.116	0.458	−0.617	0.346	−0.175	1.232
Condition[a]	0.943	2.181	0.171	1.651	−6.881	6.049
Condition*Diaries handed in[a]	−0.466	0.553	−0.556	0.419	2.624	1.567
Condition*Presence parent meetings[a]	−0.366	0.684	0.670	0.514	−0.715	1.861
Random model						
Group level variance	0.115	0.653	0.000	0.000	0.000	0.000
Individual level variance	13.426**	2.068	7.694**	1.141	108.895**	16.056
Total variance explained	40%		66%		54%	
−2* log likelihood	763.287		433.922		692.600	
χ^2 difference test[a]	$\chi^2(2) = 1.46$		$\chi^2(2) = 12.251$*		$\chi^2(2) = 2.832$*	

[2] Δ-2 Log Likelihood compared to the previous model without condition.
*p < .01.
**p < .05.
[a] The reference category (= 0) was the AL condition.

Table 2
Means and standard deviations on all variables for the AL, TL and control condition (n = 168).

		AL ($n = 54$)		TL ($n = 48$)		Control ($n = 66$)	
	Min-max	Mean	SD	Mean	SD	Mean	SD
Vocabulary							
Receptive pre-test	0–24	11.30	4.77	10.33	4.19	11.55	4.39
Receptive post-test	0–24	16.57	4.41	14.67	5.00	14.94	4.92
Productive pre-test	0–24	5.58	4.32	4.49	4.22	5.50	4.07
Productive post-test	0–24	8.72	4.77	8.37	4.88	8.42	4.24
General pre-test	0–175	30.50	17.00	26.63	14.33	29.12	15.90
General post-test	0–175	45.54	12.79	39.35	17.16	41.63	14.85
Control variables							
Child age		36.87	2.94	35.54	3.37	35.50	3.06
Executive functioning		.10	.37	.02	.37	.12	.43
Social functioning	0–3	2.24	.48	2.14	.43	2.32	.42
Linguistic diversity (L2)		50.0%		54.2%		42.4%	
Child gender (boys)		61.1%		45.8%		59.1%	
Education mother	0–6	4.61	1.09	4.19	1.18	4.38	1.02

Table 3
Final multilevel models for receptive, productive and general vocabulary ($n = 168$).

	Receptive vocabulary		Productive vocabulary		General vocabulary	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Fixed model						
Intercept	16.02**	1.336	8.656**	0.968	36.629**	3.708
Pre-test	0.481**	0.081	0.680**	0.075	0.433**	0.069
Age	0.018	0.102	−0.047	0.073	−0.530	0.289
Gender (0 = girl)	−1.281*	0.629	−0.223	0.443	−0.004	1.709
Executive functioning	0.520	0.447	0.442	0.331	2.680*	1.228
Social functioning	0.741	0.823	0.903	0.601	7.462**	2.234
Linguistic diversity (0 = L2)	−1.750**	0.655	−1.475**	0.546	−2.587	1.945
Education mother	0.069	0.270	0.072	0.194	1.160	0.749
Condition (0 = control)						
Active learning	1.879*	0.747	0.479	0.663	4.846*	2.022
Technology-enhanced learning	0.118	0.741	0.866	0.654	1.848	2.058
Random model						
Group level variance	0.000	0.000	0.317	0.358	0.000	0.000
Individual level variance	12.647**	1.501	6.304**	0.780	96.882**	11.378
Total variance explained	45%		68%		58%	
−2* log likelihood	763.287		674.713		1074.648	
χ^2 difference test[a]	$\chi^2(2) = 6.631$*		$\chi^2(2) = 1.585$		$\chi^2(2) = 5.475$	

Note: *$p < .05$, **$p < .01$.
[a] Δ-2 Log likelihood compared to the previous model without condition.

diversity also predicted productive vocabulary, with L1 children showing higher productive vocabulary scores. The other covariates were not related to productive vocabulary. Including condition did not improve model fit (Δ-2LL = 1.585, df = 2, p = .460), and there was no effect of condition. The final model explained 68% of the total variance.

For general vocabulary, the covariates executive and social functioning significantly related to general vocabulary. Compared to Model 1, model fit significantly improved (Δ-2LL = 43.110, df = 6, p < .001). In the final model, condition was included. There was a significant condition effect: children in the AL condition had significantly higher general vocabulary scores than the control group (B = 4.846, SE = 2.022, p = .016, Cohen's d = 0.32), whereas the TL condition did not differ from the control group (B = 1.848, SE = 2.058, p = .369, Cohen's d = 0.12). The resulting Model 3 had a better fit than Model 2 (Δ-2LL = 5.475, df = 2, p = .065) and 58% of the variance was explained. To summarize, there was a positive effect of AL on curriculum-based receptive vocabulary and general vocabulary.

4. Discussion

In this study, we examined the effects of a family literacy program that included active learning during parent group meetings (AL) and technology-enhanced learning with real-time interaction support (TL) on vocabulary development of children attending preschools. There was a positive effect of the family literacy program, including AL, on both curriculum-specific and general vocabulary development. Children involved in AL had larger receptive vocabulary gains compared to control children who were only involved in a preschool-only program. Their productive vocabulary gains were the same. No evidence was found for vocabulary benefits of the family literacy program including TL. These effects were established within the Dutch educational context with a heterogeneous sample of families (i.e., multilingual, multicultural, low-educated and high-educated parents).

These results show strong support for the proposed mechanism that training parents' interaction behavior via active learning activities in a family literacy program facilitates children's vocabulary development. Effects of this approach were established on both receptive curriculum-based and general vocabulary development. Research has repeatedly concluded that changing parents' interaction behavior with their young children is challenging (Grindal et al., 2016; Halpern, 2000). Moreover, home-based programs that target the behavior of parents are less likely to have positive effects than programs that directly target children (Blok et al., 2005). This study demonstrates that involving parents in active learning activities, such as modeling, opportunities to practice and interactive discussions to elaborate on interaction behavior, is an effective way to produce changes in their children's vocabulary development.

Using different vocabulary tasks, our study contributes to existing literature (i.e. Grindal et al., 2016; Van Steensel et al., 2011) by providing a fine-grained picture of AL program effects. This picture showed that AL particularly improved receptive vocabulary development (curriculum-based and general). It indicates that children understand vocabulary used inside and outside the program, but that they were not yet able to actively use curriculum-based vocabulary because no effects on productive vocabulary development were found. As vocabulary knowledge exists on a continuum where receptive vocabulary precedes productive knowledge (Nagy & Scott, 2000), we assume that program effects on productive vocabulary knowledge develop at a later moment in time. These results stress the importance of measuring program effects with different vocabulary tasks.

Compared to previous studies measuring effects of family literacy programs (Van Steensel et al., 2011), the effect sizes of AL, with Cohen's d = 0.32 and 0.38, are substantial and amount to a small-to-medium effect. The size of the experimental AL effect is larger than aggregated effect sizes from meta-analytic studies (Blok et al., 2005; Grindal et al., 2016; Kaminski et al., 2008), which generally report small effect sizes. Further, parents were trained during a limited number of parent meetings (four, one for each theme) and the intervention period of 24 weeks was fairly short. Treatment fidelity measures showed that program implementation was adequate, although a number of parents did not attend all parent meetings. Moreover, because of the heterogeneous nature of the sample, teachers were faced with the challenge of training parents of different linguistic, educational and cultural backgrounds in one group. These restrictions and challenges, and the relatively small sample (n = 168), underscore the strength of the AL intervention. Thus, combining a home literacy program focused on active learning activities with a center-based program is an effective way of stimulating children's vocabulary development.

Contrary to our expectations, children in the family literacy program including TL did not outperform children in the control group on the vocabulary tasks. In a more artificial study where parent training was performed by researchers rather than teachers, Teepe et al. (2017) did find that technology-enhanced storytelling with parents receiving real-time interaction support, fostered parent–child interaction quality and children's vocabulary development. This effect was not replicated in the naturalistic setting of a family literacy program in which teachers implemented the program. TL works in a controlled setting, but implementation in the complex setting of the preschool faces greater challenges.

A first challenge was familiarizing the preschool teachers with TL. Even though we extensively trained teachers, it seemed that we were not able to completely familiarize them with the tablet computer and the technology-enhanced storytelling activity, and provide them with the required technological self-efficacy. As Voogt et al. (2013) emphasized, effects of technology-enhanced learning largely depend on teachers' computer skills and their technological self-efficacy. As a result of their limited knowledge and skills, transfer of the activity to parents during the group meetings was not optimal. TL parents visited significantly more parent meetings than AL parents, which might reflect their need of more instruction. A second challenge was the technological issues that both teachers and parents faced. In some preschools, no wifi connection was available to update the activity and some tablets were repeatedly giving errors. These problems hampered successful transfer during the parent meetings and as a consequence may have impeded the implementation at home as well.

The lack of TL effects could also be more program related. TL consisted of one technology-enhanced activity and eight regular program activities. The impact of one technology-enhanced storytelling activity might have been too small to establish a transfer to other activities and an increase in children's vocabulary development. To conclude, technology-enhanced storytelling may work in a controlled setting (//author identifying information removed//), yet it is challenging to successfully implement it in a more naturalistic setting where challenges are faced and greater intensity is required.

Some limitations should be mentioned. Firstly, policy constraints did not allow us to randomly assign preschools to conditions. Even though no significant differences between conditions were found at pre-test, possible selection effects cannot be fully excluded. The TL group seemed somewhat weaker overall, with lower scores than the AL and control groups on nearly all variables at child level. This could have affected the impact of the TL condition. Second, our sample suffered from attrition which resulted in reduced statistical power. Although we recruited 15% more children than estimated with a power-analysis (223 children were recruited versus the required 192), the final dataset included

168 cases because of missing data. Finally, this study included a quite heterogeneous sample, including families of diverse linguistic, educational and cultural backgrounds. By including background variables as covariates, we could reduce the large variance and provide a clear picture of actual program effects. At the same time, it is difficult to conclude which families benefit (most) from the program. The limited sample size did not allow us to further investigate differential learning gains for different subgroups. To invest efficiently with optimal results for families in need, future research must consider the impact of the program for different subgroups.

There are further recommendations for future research regarding program components and design characteristics. In the current study, transfer of the program and training parents' interaction behavior was conducted via parent group meetings. Previous research has shown that parent-child interaction and children's vocabulary especially benefit from home visits (Grindal et al., 2016; Kaminski et al., 2008), because home visits can facilitate the transfer of interaction behavior learned in the parent meeting to the home environment. To further increase the impact of family literacy programs, future research should consider investigating the effect of combining these two effective components.

It also remains to be determined how the program influenced the quality and sensitivity of linguistic input provided by parents. The current study focused on child outcomes, whereas Kaminski et al. (2008) showed that taking into account both parental and child outcome measures provides a complete picture of program effects. Future studies could therefore include, for example, a measure of the technological self-efficacy of teachers or a measure to chart parent interaction behavior in detail before and during the program. This would provide a reflection of the full proposed mechanism of vocabulary development via teacher instruction at parent meetings and parent-child interaction at home. In addition, follow up measures would provide insight into the sustainability of the vocabulary gain and parents' interaction behavior over a longer period of time. As a final recommendation, we suggest conducting more research into how programs are actually implemented. In addition to the more quantitative implementation measures included in the current study, future research could include more qualitative implementation measures, such as the quality of transfer from trainers to parents. Finally, in the current study, the quality of the center-based program offered in the preschool and the role of the teacher in this was not taken into account. Previous research showed the importance of the interaction between the home and preschool program for creating the most optimal learning situation (Pinto, Pessanha, & Aguiar, 2013). Moreover, recent research showed that effects of Dutch preschool education are on average small (Fukkink, Jilink, & Oostdam, 2017), although there may be variation among centers. Therefore, it can be recommended that future studies should investigate the instructional quality in both home setting and center setting in relation to vocabulary effects.

The results of this study have implications for preschool teachers, program developers and policy. Preschool teachers play a crucial role in training parents and supporting them to conduct activities of the program at home. Therefore, it is important for preschool teachers to invest in the skills required to successfully implement a family literacy program. Most preschool teachers are used to teaching children and not so much to instructing groups of parents. Therefore, program developers should be aware of the high demands placed on preschool teachers in conducting a family literacy program, including the delivery of a training for parents. It is important to intensively prepare teachers for their role to train and support parents and address different teacher abilities that are involved. Moreover, conducting successful parent meetings requires specific organizational skills (i.e., planning meetings, ensuring wifi connections) and social skills (i.e., creating a safe atmosphere during parent meetings and good relationships with parents). It is, therefore, vital that teachers and program developers are aware of these requirements.

The general advice to policy makers is to invest in family literacy programs for preschool children. Involving parents in their child's development and improving their interaction skills has a positive effect on children's vocabulary development. Considering the importance of vocabulary for learning to read and write later on, involving families in family literacy programs during preschool may help children making a better start at formal schooling. However, policy makers should take into account the effort, challenges and investment of both parents and teachers when implementing this type of program.

The main strength of this study is that two different approaches to support the interaction behavior of parents during literacy activities were examined at the same time. To identify the effects of each approach a rigorous study design was applied, including three different vocabulary tasks to establish program effects and several measures to identify implementation quality. Moreover, AL and TL were investigated within the same family literacy program to eliminate program effects, and they were compared to a control group that was involved with a similar curriculum with the same themes in preschool. In addition, the study was conducted in a naturalistic school setting which contributes to the external validity of our findings, with parents being trained by preschool teachers rather than by researchers. Finally, theoretically relevant covariates were taken into account in the analyses to control for the heterogeneity of our sample and to provide a clearer picture of actual program effects.

5. Conclusion

The present findings demonstrated that curriculum-based and general vocabulary development of preschool children benefits from a family literacy program in which parents are involved in active learning activities. A family literacy program including technology-enhanced learning seemed to have no effect on children's vocabulary development. These results demonstrate the challenges that are faced when implementing technology-enhanced interventions. Above all, it shows the important role both teachers and parents play in stimulating children's vocabulary at home.

Conflict of interest

There was no conflict of interest.

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Appendix A.

See Table A1

Table A1
Bivariate correlations between study variables ($n = 168$).

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Vocabulary														
1. Receptive pre-test	1													
2. Receptive post-test	.60**	1												
3. Productive pre-test	.63**	.55**	1											
4. Productive post-test	.67**	.63**	.80**	1										
5. General pre-test	.71**	.61**	.70**	.74**	1									
6. General post-test	.64**	.71**	.64**	.74**	.67**	1								
Control variables														
7. Child age	.14	.18*	.22**	.16	.27**	.11	1							
8. Child gender[a]	−.13	−.22**	−.03	−.11	−.07	−.05	.02	1						
9. Executive functioning	.47**	.46**	.59**	.57**	.52**	.44**	.42**	.01	1					
10. Social functioning	.40**	.39**	.51**	.48**	.44**	.49**	.23**	.13	.44**	1				
11. Linguistic diversity[b]	−.35**	–	−.56**	−.57**	−.48**	−.44**	−.08	−.05	−.21**	−.29**	1			
12. Education mother	.11	.08	.10	.05	.13	.12	.01	−.12	.04	−.02	−.05	1		
Treatment fidelity[c]														
13. Diaries handed in	.04	.10	.05	.09	.04	.15	.10	−.01	.05	−.08	−.04	.14	1	
14. Presence parent meetings	−.10	−.02	−.09	−.07	−.06	−.03	.08	.08	−.09	−.18*	−.20*	.06	.70**	1

Note: $^{*}p < .05$, $^{**}p < .01$.
[a] 0 = girl, 1 = boy.
[b] 0 = L1, 1 = L2.
[c] Only computed for AL and TL conditions ($n = 102$).

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