The influence of preschool home literacy activities on early language development

An assessment with the Language Environment Analysis system

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Abstract

In this study we tested whether the richness of the home literacy environment, operationalized by the number of baby books at home, influences the language input and thus the language development of the child, taking the parents' educational level, the infants' temperament and the number of children in the family into account. A revolutionary device to objectively and directly assess the home language environment was used, the Language Environment Analysis system (LENA). Thirty-seven parent-child dyads were interviewed when their infants were 10-14 months old about the background of the family and the temperament of the child, and a LENA recording was made. Results support previous research on the positive predictive effect of the number of baby books on the number of parent-child interactions and the infants' language development. The predictive effects of the background variables were mixed. Nevertheless, the results highlight the importance of a rich home literacy environment for parent-child interactions and early language development.

Introduction

Several studies have indicated that early parent-child interactions strongly affect the language acquisition of an infant (Topping, Dekhinet, & Zeedyk, 2013). A large amount of the language input in infancy occurs through daily verbal interactions with the parents and these parent-child conversations have been found to positively influence the infants' language development (Zimmerman et al., 2009). The quantity of the interactions in infancy positively influences both the infants' expressive vocabulary at 24 months (Weisleder & Fernald, 2013) and early receptive vocabulary growth (Schmitt, Simpson, & Friend, 2011). Besides the quantity, the quality of the interactions has been also found to be an important contributor to the infants' language development (Topping, Dekhinet, & Zeedyk, 2013). The quality of the interaction is high when the attention of the infant is entirely aimed at the communicating parent (Topping, Dekhinet, & Zeedyk, 2013). For a positive effect on linguistic development, mutual engagement of the speaker and the child seems to be important (Shneidman, Arroyo, Levine, & Goldin-Meadow, 2013).

One way to engage in these high-quality reciprocal interactions at home is through shared book reading (Brockmeyer et al., 2012; Duursma, Augustyn, & Zuckerman, 2008).The beneficial effects of early pre-literacy activities on language development have been demonstrated by several studies (Topping, Dekhinet, & Zeedyk, 2013). Shared book reading in eight months old infants predicted their language abilities at both 12 and 16 months (Karrass & Braungart-Rieker, 2005). A recent Dutch study on the effect of Bookstart, an intervention program to promote preschool joint book reading, revealed that parents who engaged more often in shared reading as a result of Bookstart had infants with higher language scores at 15 months old (Van den Berg & Bus, 2015). The positive effects of shared book reading seem to be related to the finding that during shared book reading, parents use more complex language (Fletcher & Reese, 2005). For example, parents use more complex sentence constructions during shared book reading than during play (Cameron-Faulkner & Noble, 2013). In addition, children are exposed to novel words during shared book reading which they barely encounter in daily interactions (Dickinson, Griffith, Golinkoff, & Hirsh-Pasek, 2012). These results highlight the importance of a rich home literacy environment to engage the parents and the infant in reciprocal interactions at an early age to stimulate language development.

Variability in the amount of language input across families is present and one factor associated with these differences is the socioeconomic status of the family (Topping,

Dekhinet, & Zeedyk, 2013). In a longitudinal study, Hart and Risley (2003) compared the language input of three year old children from families with high socioeconomic status and families on welfare. Children from families on welfare overheard 616 words per hour on average, whereas children from families with high socioeconomic status overheard 2153 words per hour on average (Hart & Risley, 2003). As a result, differences in the children's language development were visible as well: the vocabularies of the children from families on welfare were substantially smaller compared to the vocabularies of children from families with high socioeconomic status (Hart & Risley, 2003). A comparison between families with high- and middle socioeconomic status revealed that mothers with high socioeconomic status not only talked more to their child, but used more enriched vocabulary compared to mothers with middle socioeconomic status as well (Hoff-Ginsberg, 1998). The socioeconomic differences are also present in the infants' home literacy environment. Research has shown that mothers more often participated in shared book reading with their infant when the family income was higher (Karrass, VanDeventer, & Braungart-Rieker, 2003). In a study examining the attitudes towards shared book reading to infants in a sample with mothers with low socioeconomic status, it was found that a large proportion of these mothers did not have plans to undertake infant shared book reading (Berkule, Dreyer, Huberman, Fierman, & Mendelsohn, 2007). Also, many mothers did not have any baby books available at home at the time of delivery (Berkule et al., 2007). Because of the beneficial effects of shared book reading, children from low-educated families with a poorer home literacy environment are at risk of lower amounts of exposure to language input through interactions and thus, a disadvantageous language development.

Parental socioeconomic status is not the only factor affecting the amount of parental language input; parents are less likely to talk to children with a more reactive temperament (Dixon & Smith, 2000). Children with a difficult temperament are prone to anger, express more negative emotionality and have poor effortful control (Kochanska & Kim, 2013). With regards to the language development, children with characteristics of a more easy temperament have a larger vocabulary compared to children with characteristics of a more difficult temperament (Dixon & Smith, 2000). An explanation for this difference might be that the parent-child interaction is affected by the child's temperament. Mothers who provided their infant with higher scores for negative temperament used fewer words and less complex language in the interaction with their infant (Vernon-Feagens et al., 2008). The child's temperament seems to influence the infants' home literacy environment as well. Infant temperament has been found to be a significant predictor of frequency and duration of father-

infant joint reading (Karrass, VanDeventer and Braungart-Rieker, 2003). In addition, children with high levels of temperamental reactivity, namely showing less positive and more negative emotions, have been found to be less frequently involved in reading activities with their parents (Van den Berg & Bus, 2014). Parents might become frustrated and unsatisfied during interactions with their child due to the negative verbal reactions of the infant as a result of their temperament (Van den Berg & Bus, 2014). Thus, a reactive temperament of the infant places the child at risk of poorer home literacy environment and as a result, lower amounts of language input. A less beneficial language development might be a consequence of this.

The literature described here illustrates which factors play a role in the home literacy environment of an infant and the influence on the language development. However, the language development is often assessed with the use of parental-report measures, for example the MacArthur-Bates Communicative Development Inventories (CDI's; Fenson et al., 2000). Questionnaires assess the language development indirectly and are prone to social desirability bias of the parents (Bryman, 2008). The development of the Language Environment Analysis System (LENA) has brought changes to this issue. With the LENA system, the language environment of infants and toddlers can objectively and directly be examined (Gilkerson & Richards, 2008). The target child carries a LENA digital language processor (dlp), which makes recordings of the audio environment (Xu, Yapanel, & Gray, 2009). The software analyzes the audio recorded and segments the information into three main outcome measures: adult word count, child vocalizations and conversational turns (Gilkerson & Richards, 2008). A reliability analysis of the LENA system, in which the LENA segmentations were compared to segmentations made by human coders, revealed high agreement (Xu, Yapanel, & Gray, 2009).

The aim of the present study is to examine whether a rich home literacy environment influences the language input and thus the language development of the child as measured with the LENA system. It is hypothesized that the home literacy environment is a positive predictor of parent-child verbal interactions and language development of the child. Because the number of books available is one of a number of variables to determine the home literacy environment (Payne, Whitehurst, & Angell, 1994), the richness of the home literacy environment will be assessed with the number of baby books available at home. In the current study, we examined the verbal interactions and child language development with an objective and direct measure of language (LENA). As the quantity of parent-child interaction is associated with the educational level of the parents (Hart & Risley, 2003) and the temperament of the child (Vernon-Feagens et al., 2008), we took these variables into account

in the analyses. Furthermore, home literacy environment is found to be positively related to the number of children in the family because siblings positively affect the frequency of language interaction and joint play (Topping, Dekhinet, & Zeedyk, 2013). In addition, it is likely that there are more baby books at home when a child has more siblings. We therefore added the number of children in the family to the analyses as well.

Method

Participants

Parents (*N* = 174) visiting the well-baby center with a child aged between six and nine months old in five different sites in the Netherlands (The Hague, Hilversum, Naarden-Bussum, and Vlaardingen), were interviewed about educational level and language at home. After the interview, parents were invited to participate in a follow-up study. Seventy parents agreed to participate in the follow-up study, 75 parents were not willing to participate and 29 parents did not respond to phone calls or emails or were not capable of answering the questions for the follow-up study in Dutch. Parents who agreed to participate were contacted and an appointment for the home-visit was made. At the end of the home-visit, parental permission was inquired for the use of the LENA device at home. More than half of the parents (54.3%) agreed to make a recording with the LENA device. For the purpose of this study, only parent-child dyads in which a (successful) recording was made at home with the LENA device were included, resulting in a sample of 38 parent-child dyads. Almost half of the children in the sample were boys (*N* = 20). The home visits were made when the children were aged between 10 and 14 months (*M* = 11.67, *SD* = 1.21) and the LENA recording was made when the children were aged between 10 and 18 months (*M* = 12.63, *SD* = 1.75). Approximately half of the families lived in a site in which Bookstart was implemented (*N* = 20; The Hague, Hilversum and Schiedam) and the remaining half of the sample belonged to the control group (*N* = 18; Naarden and Vlaardingen). The parents in the sample completed at least Senior General Secondary Education (*N* = 2) or Senior Secondary Vocational Education (*N* = 10) and the majority of the sample completed Higher Vocational Education *(N* = 14) or University (*N* = 12).

Procedure

Between March and July 2013, parents were interviewed in the waiting room of the well-baby center about the reading and language activities at home with their child. Parents

received a folder containing information about the follow-up study. When parents agreed to participate, they were contacted by the researcher approximately four months later to make an appointment for the home-visit.

Two researchers visited the parents and the child at home. Researchers orally interviewed parents the questions of the Infant Behavior Questionnaire-revised (IBQ-r). All children received a small present for their participation (i.e., a book or a small toy). At the end of the home-visit, parents were informed about the use of the LENA device to register home language use, and were asked to participate. If parents agreed, they received instructions, a LENA device and a specially designed t-shirt for the device. Parents were instructed to make a 10 hour long recording on a day the child was at home and did not attend daycare. The researcher contacted the parents to inform whether the recording was completed, after which the LENA device was retrieved from the parents by the researcher.

Instruments

Background Information. A questionnaire was completed by the parents to obtain information about the background of the families. The questionnaire addressed the child's age and gender, the home situation (marital status parents, primary caregiver, number of siblings), educational level of the parents, reading problems in the family, the native language spoken at home, activities related to the library and whether the parents participated in the Bookstart project. In addition, parents answered on a four-point scale (daily, a couple of times a week, a couple of times a month or (almost) never) how often they participate in different reading and language activities and parents indicated their attitudes towards several statements on reading activities on a four point scale (completely agree, agree a little, disagree a little or disagree completely). In the current study, only a selection of variables was used as the other variables were irrelevant in answering the research questions.

Infant Behavior Questionnaire – revised. A Dutch translation of the Infant Behavior Questionnaire-revised (IBQ-r; Gartstein & Rothbart, 2003) was used to assess child temperament. Twenty-two items were extracted from the *Smile and Laughter* and *Activity* scale. The parents completed items concerning the question how often the child showed several behaviors in specific, recently occurring situations (e.g. during eating, sleeping, undressing, bathing, washing) on a 7-point Likert scale. The scale ranged from *never* (1) to *always* (7) and *not applicable* (8) was an option as well.

Language Environment Analysis (LENA) digital language processor (DLP). The Language Environment Analysis (LENA) digital language processor (DLP) was used to

examine the amount of vocalizations produced by the child. Also, the LENA device measured the amount of words spoken by the parents, conversational turns between the parents and the child within 5 seconds, distant speech, meaningful speech, noise, TV and electronics and silence. American normative data is available for 2-48 months old English-speaking children (Gilkerson & Richards, 2008). Dutch validation data is available as well (Van den Berg & Bus, 2015).

Statistical analyses

The Statistical Package for Social Science (IBM SPSS) was used to perform all the analyses. In the preliminary analyses, a data inspection was performed to analyze the data in terms of normality, outliers and missing values. To examine whether the number of baby books predicted the number of vocalization produced by the child, the number of words produced by the parents and number of conversational turns between the parents and the child, controlling for the influence of background variables, three separate hierarchical multiple regression analyses were performed. In all three regression analyses, the background variables educational level, child temperament and the number of children were included in the first step as predictors and the number of baby books was included in the second step as predictor.

Results

Preliminary analyses

LENA. The variables with the number of vocalizations produced by the child, number of words produced by the parents, and the number of conversational turns were corrected for sleeping time and number of hours recording. Parents were instructed to make a ten hour recording, in order to extract the data from the device. However, some of the recordings exceeded ten hours. In addition, all children slept at least once during the recording, but the duration of sleep differed per child. As a result, the LENA data was difficult to compare between families. After correction, the data extracted consisted of seven hour long recordings without sleep for all children.

Temperament. The temperament variable was first recoded such that the option *not applicable* (8) was transformed into a missing value. According to previous research, six items of the IBQ-r have high loadings on temperamental reactivity (Van den Berg & Bus, 2014). These six items assess emotional reactivity of the infant during dressing, bathing,

washing of the face, washing of hair, playing and lying on the back. For the purpose of this study the six variables were rescaled in such a way that high scores represent high reactivity. Finally, a sum score of the six recoded items was computed.

Data inspection. Data inspection of the included variables revealed no missing values. An extreme score was found on number of baby books for one parent-child dyad and this dyad was therefore excluded from the analyses. The descriptive statistics for the remaining 37 dyads are presented in Table 1. The Kolmogorov-Smirnoff test for normality was non-significant for child vocalizations, words produced by the parents, conversational turns, child temperament and number of baby books (all $p = .20$), indicating a normal distribution, and was significant for number of children and educational level (both $p < .01$), indicating a non-normal distribution. However, the sample size in this study was small and therefore, the results should be interpreted with care. The skewness and kurtosis values for number of children indicated that the distribution was slightly skewed to the right and the skewness and kurtosis values for educational level indicated that this distribution was slightly skewed to the left. However, the skewness and kurtosis values for these variables were still within acceptable ranges and therefore, this variable could be used in the analyses. The skewness value for number of baby books indicated a distribution slightly skewed to the right as well, but the value was also still within acceptable ranges.

Table 1
Descriptive statistics

	N	*Min*	*Max*	*M*	*SD*	$z_{skewness}$	$z_{kurtosis}$
Child vocalizations	37	64.78	299.80	164.79	68.42	1.32	-1.01
Words parents	37	481.72	1921.67	1169.73	381.03	.71	-1.28
Conversational turns	37	11.82	75.77	36.82	16.33	.84	-.73
Child temperament	37	1.50	5.50	3.24	.99	.63	-.77
Number of baby books	37	0	50	17.97	11.17	2.18	.93
Number of children	37	1	4	1.92	.89	1.70	-.44
Educational level	37	4	8	6.86	1.03	-2.57	1.75

$z_{kurtosis}$ = kurtosis / standard error of kurtosis
$z_{skewness}$ = skewness / standard error of skewness

Finally, in testing multicollinearity, none of the correlations in the three separate correlation matrices for child vocalizations, words produced by the parents and conversational turns with child temperament, number of baby books, number of children and educational level exceeded $r = .70$ and therefore, it could be concluded that there was no multicollinearity present in de dataset (Table 2).

Table 2

Correlations

	Number of baby books	Temperament Child	Number of Children	Educational level
Number of baby books	1.000			
Child temperament	-.096	1.000		
Number of Children	.403*	.234	1.000	
Educational level	.267	.114	.289	1.000
Child vocalizations	.349*	.291	.070	.190
Words parents	-.042	-.075	-.304	-.100
Conversational turns	.166	.173	-.181	-.052

* p <.05

Main analyses

In all three separate hierarchical regression analyses, child temperament, number of children and educational level were included in the first step (model A), and the number of baby books was added in the second step of the multiple regression analysis (model B).

Number of vocalization produced by the child. The first regression analysis was performed with the number of child vocalizations as dependent variable. The first model (1A) was not significant, $F(3,33) = 1.38$, $p = .27$. None of the variables in the model were significant predictors of child vocalizations (Table 3). The second model (1B) with number of baby books included, was significant, $F(4,32) = 2.96$, $p = .03$. The R^2 change for model 1B was significant, $F(1,32) = 6.96$, $p = .01$. The predictor variables in model 1B together accounted for 27% of the variance in the number child vocalizations, $R^2 = .27$. The regression weights for both child temperament and number of baby books were positive and significant (Table 3), which indicates a positive relation between a reactive temperament of the child and the number of vocalizations produced by the child, and a positive relation between the number of baby books and the number of vocalizations produced by the child. If the rating on temperamental reactivity increases, the number of child vocalizations raises as well. In addition, if the number of baby books available at home becomes larger, the number of child vocalizations increase as well.

Table 3

Summary hierarchical regression analysis for variables predicting child vocalizations (N=37)

	Model 1A				Model 1B			
	B	SE	β	*t*	*B*	SE	β	*t*
Child temperament	19.63	11.74	.28	1.67	26.36	11.10	.38	2.38*
Number of children	-3.70	13.45	-.05	-.28	-17.75	13.48	-.23	-1.32
Educational level	11.36	11.38	.17	1.00	6.10	10.66	.09	.57
Number of baby books					2.78	1.05	.45	2.64*

*: p <.05

The proportion of unique variance explained by the variables equals the squared semipartial correlation. For child temperament, the proportion of unique variance was $r^2 = (.359)^2$, which equals 13%. For number of baby books, the proportion of unique variance was $r^2 = (.398)^2$, which equals 16%. Thus, child temperament uniquely accounted for 13% and number of baby books uniquely accounted for 16% of the variance in the number of vocalizations produced by the child.

Number of words produced by the parents. The second regression analysis was performed with the number of words produced by the parents as dependent variable. Neither in model A or B the predictor variables significantly predicted the amount of words produced by the parents, respectively $F(3,33) = 1.12$, $p = .36$ and $F(4,32) = .901$, $p = .48$. In model B, the number of baby books was a marginally significant predictor of the number of words produced by the parents. The positive regression weight indicates a positive relation, thus an increase in the number of baby books results in a raise in the number of words produced by the parents. None of the remaining predictors was significant (Table 4).

Table 4
Summary hierarchical regression analysis for variables predicting the number of words produced by the parents (N=37)

	Model 2A				Model 2B			
	B	SE	β	*t*	*B*	SE	β	*t*
Child temperament	-.39	66.06	.00	-.01	8.47	68.60	.02	.12
Number of children	-127.65	75.72	-.30	-1.69	-146.15	83.31	-.34	-1.75
Educational level	-5.10	64.05	-.10	-.08	-12.02	65.88	-.03	-.18
Number of baby books					3.66	6.51	.11	.56^{+}

$^{+}$: $p < .10$

Number of conversational turns. The third regression analysis was performed with the number of conversational turns between the parents and the child as dependent variable. Both model 3A and model 3B were not significant, respectively $F(3,33) = 1.00$, $p = .41$ and $F(4,32) = 1.86$, $p = .14$. However, in model 3B, the variables number of children and number of baby books were significant predictors of the number of conversational turns, and child temperament was a marginally significant predictor (Table 5). Therefore, the regression analysis was performed a second time without the non-significant predictor educational level. The results are presented in Table 6.

The results show that model A was not significant, $F(2,34) = 1.54$, $p = .23$, but model B was marginally significant, $F(3,33) = 2.47$, $p = .08$. The R^2 change for model 4B was significant, $F(1,33) = 4.07$, $p = .05$ and 18% of the total amount of variance was explained by

the variables child temperament, number of children and number of baby books, $R^2 = .18$. Both the number of children and the number of baby books were significant predictors of the number of conversational turns and child temperament was a marginally significant predictor (Table 6). For the conversational turns, the regression weights indicated a negative relation with the number of children, and a positive relation with both the number of baby books and temperamental reactivity. If the number of children in the family increases, the number of conversational turns between the target child and the parents decreases. In contrast, if the number of baby books or the temperamental reactivity score of the child increases, the number of conversational turns between the target child and the parents raises as well.

With regards to the proportion of unique variance of conversational turns explained by the predictors separately, this was $r^2 = (-.346)^2$ for number of children, which equals 12% and $r^2 = (.317)^2$ for number of baby books, which equals 10%. The number of children uniquely accounted for 12% and number of baby books uniquely accounted for 10% of the total amount of variance in the number of conversational turns between parents and the target child.

Table 5

Summary hierarchical regression analysis for variables predicting conversational turns (N=37)

	Model 3A				Model 3B			
	B	SE	β	*t*	*B*	SE	β	*t*
Child temperament	3.83	2.85	.23	1.34	5.14	2.79	.31	1.84^{+}
Number of children	-4.28	3.27	-.23	-1.31	-7.01	3.39	-.38	-2.07*
Educational level	-.16	2.77	-.01	-.06	-1.19	2.68	-.08	-.44
Number of baby books					.54	.27	.37	2.04*

$^{+}$: $p < .10$

*: $p < .05$

Table 6

Summary hierarchical regression analysis for variables predicting conversational turns without educational level (N=37)

	Model 4A				Model 4B			
	B	SE	β	*t*	*B*	SE	β	*t*
Temperament child	3.82	2.80	.23	1.36	5.03	2.75	.30	1.83^{+}
Number of children	4.33	3.09	-.24	-1.40	-7.27	3.30	-.40	-2.20*
Number of baby books					.52	.26	.36	2.02*

$^{+}$: $p < .10$

*: $p < .05$

Discussion

The aim of the present study was to examine whether the home literacy environment of an infant affects the amount of language input and thus the language development of the child. In order to examine this question, we were unique in using the Language Environment Analysis (LENA) system. This revolutionary device can, in combination with the software, analyze the amount of vocalizations produced by the child, the number of words spoken by the parents and the number of conversational turns between the parents and the infant. As the parents' educational level and the child's temperament were previously found to be strong predictors of the home literacy environment, we took these variables into account when analyzing the research question. The number of children in the family was taken into account as well. Previous studies have reported that parents involve their infant in reciprocal interactions during shared book reading (Brockmeyer et al., 2012) and these interactions stimulate language development and enhance early language skills (Topping, Dekhinet, & Zeedyk, 2013). Therefore, it was expected that the home literacy environment, operationalized by the amount of baby books, would be a positive predictor of the amount of parent-child verbal interactions and the language development of the child. The results of this study support this expectation and results from previous studies: the number of baby books was a positive predictor of the amount of parent-child interactions and language development of the child, and a marginally significant predictor of the number of words produced by the parents. Using the LENA system as a direct and objective measure assessing the quantity of the language development, these results support previous research on the relation between shared book reading and infant language development. Shared book reading is a valuable way to stimulate language development by parent-child verbal interactions. This underlines the relevance of the adaptation of programs to enrich the home literacy environment of the child, especially for children at risk of a poor home literacy environment. Bookstart, for example, has been found to be an effective program to promote preschool joint book reading in the United Kingdom (Wade & Moore, 1996) and the Netherlands (Van den Berg & Bus, 2015). Hence, intervention programs such as Bookstart can diminish the substantial difference in early language experiences between children as reported by Hart and Risley (2003).

The results of this study do not support the expectation of the educational level of the parents as predicting background variable: in all performed analyses, the educational level was a non-significant predictor. The finding that educational level of the parents did not predict any of the LENA outcomes in the present study can be explained by the fact that the

educational level in the sample studied was mainly moderate to high. As mentioned, all parents completed at least Senior General Secondary Education or Senior Secondary Vocational Education and the majority of the sample completed University of Professional Education or University. As can be seen, the lowest-educated parents in the current sample are underrepresented. In addition, the lowest-educated parents in the Netherlands, namely parents who finished primary or special education, were not represented in the sample at all (Centraal Bureau voor de Statistiek [Statistics Netherlands], 2010). As a result, the variation in the educational level of current sample studied is small (Bryman, 2008). If lower-educated parents would be represented in the sample studied, it is plausible from results from previous research (e.g. Hart & Risley, 2003) that educational level would be a stronger predictor of both the language input of the parents and language development of the child.

The child's temperament was a significant positive predictor of the number of child vocalizations and the number of conversational turns between the parent and the child, but not of the number of words produced by the parent. These results indicate that a higher score on temperamental reactivity results in an increase in parental language input and the infants' language development. In contrast to findings from previous studies (e.g. Dixon & Smith, 2000; Vernon-Feagens et al., 2008), the results from the present study describe more language input and a better language development for children with a more difficult temperament. An explanation for this finding is that reactive infants ask for more attention from their parents, and parents verbally respond to this. Whether the parents verbally respond to their child might depend on their parental sensitivity. Previous research has shown that parental responsiveness and parental support are important in the interaction with infants (Vernon-Feagens et al., 2008). Parents with low sensitivity scores might respond to the negative reactivity of their infant by avoiding the interaction with their child, whereas sensitive parents might sooth their infant by talking when the infant expresses the negative emotions. Parental sensitivity might operate as a moderator in the language-temperament relation, resulting in a positive relation between temperamental reactivity and both language input and development in the current study. For future studies it is important to assess the quality of the parent-child interactions to examine the parental sensitivity, especially in temperamentally reactive children. Presumably, the moderating role of parental sensitivity might be demonstrated then. No relation was found between temperament and the number of words produced by the adult. It seems that reactive infants ask for more parental attention and sensitive parents respond to this, but the parents do not necessarily use more words in these interactions.

The results of the present study also revealed that the number of children was a

significant predictor of the number of conversational turns between the parents and the child. In contrast to the expectation, a higher number of children in the family was related to a lower number of parent-child interactions. It seems reasonable, though, that when a child has more siblings, the amount of one-to-one parental interaction is allocated over the children. Hence, an infant without siblings has a larger probability of participating in a parent-child interaction than an infant with siblings. Opposite to previous findings, the number of children in the family was not related to the infants' language development in the present study. However, the frequency of infant-sibling interactions could not be assessed with the LENA system. As a consequence, it could not be examined whether a larger number of children was actually related to an increase in sibling-infant interactions. It is possible that this increase in interactions was not present in the current sample, resulting in the absence of a relation with the infants' language development. The number of children in the family was also not related to the amount of words produced by the parents. Thus, parents do not necessarily talk more when there are more children.

Limitations

Although this study confirms the importance of early shared book reading, several limitations have to be acknowledged. For the purpose of the study, it would have been desirable to analyze a mediation model (Baron & Kenny, 1986) in which the influence of the home literacy environment on language development of the child would be assessed, with the amount of parent-child interactions as mediator. The mediating role of parental interactions on language development has been demonstrated; positive features of the parent-child interaction can enhance the child's language when the background of the parents, socioeconomic status in this case, is less beneficial (Mol & Neuman, 2014). The same mechanism might be present in the relation between home literacy and language development. However, the sample size in the current study was not sufficiently large to perform the described analyses. Therefore, it remains unclear whether the richness of the home literacy environment influences the amount of parent-child interactions, which in turn influences the child's language development (the mediation model) or whether the home literacy environment directly influences the interactions and child's language development both separately. A second limitation of the current study is that, as mentioned before, the lowest-educated parents in the sample were underrepresented. As a consequence, the sample studied is not representative, which makes it difficult to generalize the results to the entire population. As a result of the underrepresentation, the educational level of the parents was not a significant background

variable in the current study, in contrast to previous findings. In a representative sample, it is likely that the educational level of the parents would have significantly influenced the parental language input and infants' language development. A final limitation of this study concerns the fact that the LENA system merely counts the number of adult words, interactions and vocalizations, but cannot assess the content and thus the quality of the interaction. Both the quantity and the quality of the parent-child interactions are important for the infants' language development (Topping, Dekhinet and Zeedyk, 2013). The present study only assessed the quantity of the interaction and for future research, it is important to assess both. During shared book reading, parents use more complex structured sentences and more complex language, which is beneficial for acquisition of the language (Cameron-Faulker & Noble, 2013). In addition, as mentioned above, the quality of the interaction is expected to be important in the language-temperament relation for children with a more reactive temperament. Therefore, it would be interesting to assess the complexity of the language and sentence constructions used by parents in the interactions besides the quantity of language input. In order to assess both the quantity and quality of the interactions, the data from the LENA system can be combined with observational data. A complete image can provide tools for the development of intervention programs to stimulate the infants' language development at an early age.

General conclusion

The results of the present study highlight the importance of a rich home literacy environment in infancy for early language input and early language development. The effect sizes for the significant models were medium, $f^2 = .226$ and large, $f^2 = .370$ (Cohen, 1992). Early linguistic stimulation is essential for the child's language development, which in turn influences later cognitive abilities (Hohm, Jennen-Steinmetz, Schmidt, & Laucht, 2007). The present study supports results from previous research on the importance of a rich home literacy environment with a new and promising tool, which examines the language development and environment directly and objectively, the LENA system. Future research should further examine the relation between the home literacy environment, parent-child interactions and the infants' language development by analyzing a mediation model and taking parental sensitivity into account. This might provide a better insight in the exact mechanisms of the influence of literacy at home on language input and language development. Besides the use of the LENA system in observational research, the device can be used in future experimental studies as well. The LENA can for example be implemented in families at risk of low amounts of verbal interactions. When parents receive the scores of the

device and an accompanying interpretation and explanation, awareness of the importance of parent-child interactions might increase. In this way, the amount of parental language input of children at risk for a disadvantageous language development might increase and thus, positively influence the infants' language development. A pilot study in an English-speaking sample has already revealed promising results for the implementation of the LENA system to positively influence the child's language input by the caregivers (Suskind et al., 2013). The LENA system is a promising tool in decreasing the substantial differences in early language development between children.

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