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The Role of Spoken Language and Literacy Exposure for Cognitive and Language Outcomes in Children

Katrina d’Apice and Sophie von Stumm

Department of Education, University of York, York, UK

ABSTRACT

Children’s language and cognitive development are informed by adult spoken language and parental literacy behaviors, although their relative contributions have not been evaluated. Using digital audio-recorders, we unobtrusively observed the spoken language of 107 children, aged 24 to 48 months ($M = 32, SD = 6.5$), and their families over 3 days ($M = 15.1$ hours per day, $SD = 1.9$). Additionally, parents administered a cognitive test to their child and completed measures for their own literacy behaviors. The adult spoken language that children were exposed to accounted for 11% and 12% of the variance in their cognitive and language abilities. Parents’ literacy behaviors accounted independently for 4% of the variance in children’s cognitive ability but were not associated with their language ability. Parents’ literacy behaviors correlated .33 with the quantity of adult spoken language. Our findings suggest that parents’ literacy behaviors play a significant role in children’s cognitive development.

Children’s cognitive and language development is thought to vary as a function of their early life language experiences in the family home. However, it is not clear which type of early life language experience is most pervasive for children’s cognitive and language outcomes. Previous studies suggested three important contributors: (a) the quantity (Caskey, Stephens, Tucker, & Vohr, 2014; Hart & Risley, 1995; Zimmerman et al., 2009) and (b) the lexical diversity of adult spoken language that children are exposed to (Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Pan, Rowe, Singer, & Snow, 2005; Rowe, 2008), as well as (c) parental literacy behaviors (Baker, 2013; Deckner, Adamson, & Bakeman, 2006). In the current study, we explore for the first time how these three contributors are inter-related, and whether they independently predict children’s cognitive and language ability in data from naturalistic home observations.

The exposure to spontaneous adult spoken language in everyday conversations provides opportunities for children to learn words and process spoken language, which trains their ability to apply language fast and accurately (Weisleder & Fernald, 2013). For example, children who hear more diverse adult spoken language, experience more examples of different words, which then increases the lexical diversity of their own spoken language (Hoff, 2003). Furthermore, hearing these different words in a variety of contexts helps children to learn semantic knowledge about the word’s meaning (Head Zauche, Thul, Darcy Mahoney, & Stapel-Wax, 2016). In short, the exposure to adult spoken language informs children’s own language development and this effect is thought to be enhanced when adults and children engage together in literacy behaviors (Saracho, 2017).

Although no formal definition of literacy behaviors exists, the term is akin to the “home literacy environment” which describes literacy-related interactions, resources, and attitudes that parents provide in the family home (Hamilton, Hayiou-Thomas, & Hulme, 2016). While previous research used a wide...
range of measures to assess literacy behaviors (Topping, Dekhinet, & Zeedyk, 2013), the vast majority of studies rely on few indicators extracted from parent-reports, such as the number of books in the family home or the frequency of joint book reading (Baker, 2013; Griffin & Morrison, 1997; Puglisi, Hulme, Hamilton, & Snowling, 2017). For the current research, we applied a more comprehensive assessment approach based on three established psychometric scales (Bennett, Weigel, & Martin, 2002; DeBaryshe & Binder, 1994). Thus, we broadly captured formal and informal literacy behaviors that parents typically engage in with their child, for example reciting nursery rhymes, playing language games, storytelling, singing songs and joint book-reading, as well as parental literacy beliefs, which refer to goals, values, and ideas held by parents about literacy (DeBaryshe & Binder, 1994).

Because literacy behaviors involve focused and rich parent-child language interactions, they have been argued to better support children’s language and cognitive development than other kinds of verbal exchanges (Baker, 2013). Specifically, previous studies suggest that parents’ literacy behaviors expose children to vocabulary that rarely occurs in spontaneous spoken language, because a broader range of rare topics are addressed during literacy-based parent-child interactions than in alternative conversation settings (Mol, Bus, De Jong, & Smeets, 2008). For example, adults engaging in narrative tasks like storytelling use more diverse spoken language than they do in spontaneous everyday conversations (Nippold, Frantz-Kaspar, & Vigeland, 2017), which in turn improves children’s vocabulary and comprehension skills (Britto, Brooks-Gunn, & Griffin, 2006; Saracho & Spodek, 2010). Likewise, joint book-reading provides the opportunity for parents to engage in behaviors such as scaffolding dialogue, questioning, relating ideas to personal real-life experiences or offering positive feedback (Saracho & Spodek, 2010), which helps children to develop problem solving skills (Saracho, 2017) and to enhance their understanding of the world (Rodriguez et al., 2009). Although spontaneous adult spoken language and parents’ literacy behaviors appear to employ similar language learning mechanisms, their relative contribution to children’s cognitive and language development are currently unclear.

**Naturalistic home observations of early life language experiences**

In early life, children typically spend most of their time in the family home, yet naturalistic home observations of children’s exposure to adult spoken language are rare. Studies that do conduct home observations usually involve researchers visiting the homes of families: the physical presence of a researcher may trigger observer reactivity, with any observations not being truly representative of families’ natural language and behavior (Dudley-Marling & Lucas, 2009; Gardner, 2000). For example, mothers were found to use more positive language and engage more with their child in the presence of a researcher compared with when they were alone with their child (Zegiob, Arnold, & Forehand, 1975).

The Language Environment Analysis (LENA) system uses digital audio-recorders, which are worn in pockets of custom-made children’s clothing, to unobtrusively document acoustic environments. LENA enables collecting naturalistic observations of children’s language experiences, without observer biases, for up to 16 hours (i.e., full days) and estimates the number of words that the study child has heard from adults, including parents, other relatives and carers, and visitors (Gilkerson & Richards, 2009).

Previous studies that used LENA reported positive associations between the quantity of adult spoken language (i.e., the number of adult spoken words) in the home environment and children’s own language ability. For example, Zimmerman et al. (2009) found in a sample of 275 families with children aged 2 to 24 months that each 1000 word increase in adult spoken language corresponded with a 0.44 SD gain in Preschool Language Scale scores (PLS-4; Zimmerman, Steiner, & Pond, 2002). Recently, Gilkerson et al. (2018) reported that the quantity of adult spoken language that children were exposed to between the ages of 2 and 47 months accounted for 7% of the variance in their language ability at age 9 to 14 years. These findings are aligned with the usage-based theory of language acquisition, whereby an enriched language environment provides more lexical and syntactic examples from which children can construct language (Abbot-Smith & Tomasello, 2006; Tomasello, 2009).

While the association between the quantity of adult spoken language and children’s language development is well established (see Head Zauche et al. (2016) for a review), we only identified two
previous studies that used LENA to test the relationship between the quantity of adult spoken language and children’s cognitive outcomes. The first reported in a sample of 26 preterm infants that the quantity of adult spoken language that the infants experienced at age 36 weeks accounted for 26% of the variance 10 months later in composite scores across five cognitive domains (cognitive, language, motor, social-emotional, and adaptive behavior; Caskey et al., 2014). The other one is Gilkerson et al.’s (2018) study, mentioned above, which found that the quantity of adult spoken language experienced from 2 to 47 months of age explained only 1% of the variance at the ages of 9 to 14 years in cognitive ability scores derived from five scales (verbal comprehension, visual-spatial, fluid reasoning, working memory, and processing speed). That is, previous estimates of the strength of the association between the quantity of adult spoken language that children are exposed to and their cognitive outcomes vary substantially in naturalistic home observational studies. We speculate that the age at which the cognitive assessments occurred may drive the differences in reported associations. For example, the quantity of adult spoken language may be extremely important for cognitive development in early life, however by childhood and adolescence, other factors such as peer-groups and schooling may become more influential (Cappella & Hwang, 2015; Roberts et al., 2015).

To the best of our knowledge, no previous LENA study has assessed the lexical diversity of adult spoken language (i.e., the number of different words) that children are exposed to in the home environment, or its association with children’s language or cognitive outcomes. However, other research that relied on non-naturalistic home observations, with researchers visiting the family home to conduct video- or audio-recordings, have shown that greater lexical diversity of adult spoken language is positively associated with children’s language outcomes (Hart & Risley, 1995; Head Zauche et al., 2016; Hoff, 2003; Huttenlocher et al., 2010; Pan et al., 2005). For example, in a sample of 108 children, those who showed greatest gains in lexical diversity from 14 to 36 months had mothers who spoke with a more diverse vocabulary themselves (Pan et al., 2005).

Only one of the aforementioned studies, which assessed adult lexical diversity, also tested children’s non-verbal cognitive ability. In Hart and Risley’s (1995) longitudinal study of 42 families, maternal lexical diversity correlated .51 with children’s cognitive ability at 36 months of age. We also identified a prospective cohort study of 1292 parent-child dyads, which reported a correlation of .11 between maternal lexical diversity and children’s cognitive ability at 15 months of age (Burchinal, Vernon-Feagans, Cox, & Key Family Life Project Investigators, 2008). The discrepancy in the strength of association may be due to differences in the lengths of the observations used to assess lexical diversity: Burchinal et al. (2008) used videotaped observations of mothers reading with their children for up to 10 minutes, whereas Hart and Risley (1995) included 23 full hours of audio-recordings that were collected over the course of 23 months. Because both studies also differed in sample size and observation method (i.e., video versus audio), we can only speculate about the reasons for the differences in effect sizes. The current study extends these earlier findings to test how the quantity and lexical diversity of adult spoken language that children are exposed to in the family home are associated with their cognitive and language outcomes, as well as with parents’ literacy behaviors and beliefs.

**Parental literacy behaviors and children’s outcomes**

Parental literacy behaviors refer to literacy-based activities that parents undertake with their children, such as storytelling and joint book reading, while parental literacy beliefs describe parents’ attitudes, perceptions and values regarding children’s literacy and language development (Weigel, Martin, & Bennett, 2005). Previous studies have shown positive associations between parents’ literacy beliefs and their engagement in literacy activities (Bingham, 2007). For example, parents who value literacy and take an active role in their children’s literacy development tend to engage more frequently in child-directed literacy behaviors, such as asking questions during joint book reading, giving feedback, and showing enthusiasm (DeBaryshe, 1995;
Sonnenschein et al., 1997). Likewise, parental characteristics, such as the amount of expression, involvement, sensitivity and teaching behaviors that parents display during literacy activities, are also positively associated with parents’ literacy beliefs (Bingham, 2007). Furthermore, parents’ literacy beliefs have been found to benefit children’s language outcomes: For example, parental literacy beliefs accounted for 11% of the variance in children’s expressive language skills at the age of 4 years in a sample of 85 families (Weigel et al., 2005).

Children exposed to more parental literacy behaviors at 27 months also had greater expressive language skills at 30 and 42 months (Deckner et al., 2006). Likewise, paternal literacy behaviors at 2 years predicted children’s expressive language ability at 4 years (Quach et al., 2018). Furthermore, a meta-analysis of 29 studies found positive effects of joint book reading on children’s language outcomes (Bus, van IJzendoorn, & Pellegrini, 1995). In addition, in a sample of 195 language impaired children, aged 59 to 96 months, those with greater familial literacy behaviors also had better expressive and receptive language skills, compared with children whose families engaged in fewer literacy behaviors (Tambyraja, Schmitt, Farquharson, & Justice, 2017).

Only a handful of studies have tested the associations between parents’ literacy behaviors and children’s cognitive abilities. For example, in a sample of 1046 families, parents’ literacy behaviors correlated .21 with children’ cognitive ability at 24 months of age (Rodriguez et al., 2009). By comparison, in a sample of 295 families, parents’ literacy behaviors were more strongly associated with children’s cognitive ability at .53, when they were aged 58 months and above (Griffin & Morrison, 1997).

In summary, previous research suggests that parents’ literacy behaviors and beliefs are positively associated with children’s cognitive and language outcomes. However, the strength of these associations has not been directly tested using naturalistic observations of children’s language ability. Furthermore, it is unknown how parents’ literacy behaviors and beliefs are related to the quantity and lexical diversity of adult spoken language, which also informs children’s cognitive and language outcomes.

The current study

The current study uses data from 107 British families to compare the relative contributions of the quantity and lexical diversity of adult spoken language and of parental literacy behaviors and beliefs in the family home to children’s cognitive and language outcomes. Because specific cognitive abilities, such as problem solving, memory and attention, are not clearly differentiated and operationalized in early life but constitute generic processes, we used the broad terms of cognitive abilities, development and outcomes when assessing and discussing children’s non-verbal cognition (Elliot, 1990; Saudino, 1998). According to constructivist approaches, language recruits domain-general learning mechanisms and thus, language and cognitive abilities are inter-related (Kidd, Donnelly, & Christiansen, 2018). However, within this framework there is scope for the notion that non-verbal cognitive abilities may also be distinct from verbal abilities; therefore, both kinds of abilities were assessed in the current study (Deák, 2014; Kidd et al., 2018).

We hypothesized that (a) the quantity and lexical diversity of adult spoken language will be positively associated with parents’ literacy behaviors and beliefs, so that families where children are exposed to more and more diverse language also experience greater literacy behavior engagement. We also hypothesized that (b) the quantity and lexical diversity of adult spoken language and parents’ literacy behaviors and beliefs will be positively associated with and each make an independent contribution to children’s language and cognitive outcomes. Finally, and although previous estimates produced a wide range of effect sizes, we predicted that (c) the quantity and lexical diversity of adult spoken language will be more strongly associated with children’s cognitive and language outcomes than parents’ literacy behaviors and beliefs, because adult spoken language is a more permanent and enduring experience in the family home than parents’ literacy behaviors and beliefs, which become salient only occasionally during the day.
**Method**

**Sample**

Initially, 225 families (236 children) that resided in Southeast London, were recruited via advertisements in nurseries ($n = 59$), on Facebook ($n = 141$), through word-of-mouth ($n = 15$) or on the authors’ lab website ($n = 10$). Of the 220 families who were eligible (i.e., monolingual English-speaking families with a typically developing child aged 24 to 48 months), 131 families completed a 1-hour online survey and subsequently received the study materials. Out of these, 107 families audio-recorded three days of interactions in their home environments for more than 5 hours per day. In six families, two children (i.e., 2 siblings and 4 twin pairs) participated in the study: to ensure the independence of observations, one sibling was randomly excluded from the analyses. For a more detailed description of the sample see d’Apice, Latham and von Stumm (2019).

The final analysis sample consisted of 107 typically developing children (mean age in months = 32, $SD = 6.5$, range = 24 to 48; 51 girls), 105 mothers (mean age in years = 37, $SD = 4.6$, range = 22.5 to 51.6), and 73 fathers (mean age in years = 39, $SD = 5.2$, range = 25.2 to 55.1). The vast majority of parents were born in Britain, with English as their native language (86% and 99% respectively), and on average they had spent 33.42 years in the UK ($SD = 10.9$, range from 0 to 55). Regarding the mothers, 28 were full-time parents; 58 were in part-time and 11 in full-time employment; 4 identified as students, and 4 were on maternity leave. By comparison, 59 of the fathers were in full-time and 10 in part-time employment, and 4 were full-time parents. Most parents had university degrees (86% of mothers and 78% of fathers) and were married co-parents (96%), most whom had been living together for 4 or more years (92%). 54% of the children had siblings living in the same household. Families varied in socio-demographic background, but they were on average of higher socioeconomic status than the general British population.

**Procedure**

The study was approved by the Ethics Committee at Goldsmiths, University of London. This study conforms to the ethical principles detailed in the Declaration of Helsinki. All participants (or their legal guardians) gave their informed consent and children gave their assent prior to their inclusion in the study. Data were collected between November 2014 and August 2016. Initially, parents completed an online survey reporting on their socio-demographic information, literacy behaviors and beliefs, and child’s characteristics.

After survey completion, study materials including (a) 3 LENA digital audio recorders (details below), (b) 3 items of LENA clothing, and (c) a Parent Report of Children’s Abilities (PARCA) booklet (details below) were hand-delivered to each family. Parents independently conducted audio recordings on 3 days when they were mainly at home, to ensure the clarity and viability of the recordings. 10 families recorded on consecutive days, although on average, recordings were conducted within a time period of 16 days ($SD = 16$; range = 2 to 92). The parents also administered the PARCA booklet to their child at home. Each family received a child’s LENA t-shirt and 79 families also received £50 in cash for their participation. Differences in compensation were due to changes in the study’s funding. There was no difference in demographics or any of the measured variables between those families that did and did not receive monetary compensation.

**Measures**

**Parental literacy behaviors**

**Literacy activities.** Parents reported 8 literacy-related activities, 7 of these items were selected from Bennett, Weigel, and Martin’s (2002) scale and supplemented with an additional item: “How often do you read to yourself for pleasure?” from DeBaryshe and Binder (1994; complete measures are
shown in the supplemental material). These 8 items assessed how often parents and children engage with literacy activities such as reading aloud, reciting nursery rhymes, storytelling and playing language games on a 6-point Likert scale (1 = hardly ever, 2 = monthly, 3 = once every fortnight, 4 = weekly, 5 = every other day, 6 = daily).

**Literacy practices.** Parents’ literacy practices were measured using a 4-item scale. Two of the items were selected from Bennett et al. (2002): “How many minutes per day do you spend reading to your child?”, rated on a 5-point scale (1 = Not a minute, to 5 = 20 minutes or more), and “How often does your child see you read?”, rated on a 6-point scale (1 = never, to 6 = more than once a day). The remaining two items were developed by DeBaryshe and Binder (1994): “How many books does your child own?” and “How old was your child (in months) when you started to read to him or her?”

**Literacy beliefs.** Parents’ literacy beliefs were measured on 18 items, selected from the Parent Reading Belief Inventory (PRBI; DeBaryshe & Binder, 1994). Literacy beliefs are organised into four distinct subscales: 1) Affect: measures positive affect associated with reading, 2) Verbal Participation: measures parents’ intentions to elicit verbal responses from their child during reading, 3) Knowledge: measures parents’ belief in the importance of reading to improve children’s morals and world knowledge, and 4) Resources: measures the parents practical capacity to participate in reading (DeBaryshe & Binder, 1994). All literacy belief items were rated on a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = don’t know, 4 = agree, and 5 = strongly agree). The affect subscale was composed of 6 items, such as “Reading with my child is a special time that we love to share”. The verbal participation subscale included 5 items, such as “I ask my child a lot of questions when we read”. Likewise, the knowledge subscale encompassed 5 items, such as “Reading helps children learn about things they never see in real life (like Eskimos and polar bears)”. The resources subscale was composed of two items: “Even if I would like to, I’m just too busy and too tired to read to my child” and “I don’t read to my child because I have other, more important things to do as a parent”.

**Language**

**Adults’ word counts.** The children “wore” the small, lightweight LENA digital audio recorders in the front pockets of specifically manufactured clothing, such as t-shirts and dungarees. These audio-recorders recorded all sounds within a six-foot radius of the study child for up to 16 hours per day. The audio-recordings were processed using the LENA Pro software version V3.4.0–143, which extracted the number of adult spoken words on each recording day (LENA Research Foundation, 2012).

**Adults’ and children’s lexical diversity.** We selected two 5-minute audio excerpts per day that registered the highest number of conversational turns (i.e., an adult-child interaction in which one speaker initiates a conversation and the other responds within five seconds) between 8am and 11am, and between 5pm and 8pm (i.e., two per day for 3 days, resulting in six 5-minute excerpts per family). These audio excerpts were transcribed by professional typists according to the Codes for the Human Analysis of Transcripts (CHAT; Macwhinney, 2000), and subsequently proofread and corrected by two trained research assistants.

To calculate a family’s adult lexical diversity score, we combined the 6 transcripts per family and assigned the same identifier code to all adult speakers within the family. The transcripts were then analysed using the VOCD command in Computerized Language Analysis (CLAN; Macwhinney, 2000) and D scores, a measure of lexical diversity, were computed (see supplemental material for details on D scores). Likewise, we computed D scores for each child by subjecting their combined transcripts to CLAN analysis.
**Children’s cognitive ability**
The Parent Report of Children’s Abilities (PARCA) assesses children’s non-verbal cognitive ability. For the current study, we selected 54 items from the PARCA versions for children aged 2, 3 and 4 years (Oliver et al., 2002; Saudino et al., 1998). First, parents reported via the online survey whether their child could perform a set of 28 activities, for example “Can your child stack three small blocks on top of each other by themselves?” Possible responses included Yes, No, and I don’t know. PARCA parent report ratings were then summed. Second, parents administered a PARCA testing booklet to their child at home, which was specifically designed to assess non-verbal cognitive abilities and therefore, the test instructions had minimal reliance on children’s ability to understand spoken instructions (Oliver et al., 2002). The booklet was composed of 9 drawing, 7 copying and 10 matching tasks, which were independently scored by two research assistants, according to the test’s scoring guidelines (Oliver et al., 2002; Saudino et al., 1998). Initial agreement rate of 92.9%, rose to 100% after differences were resolved through discussion with reference to the scoring guidelines.

The parent-report and parent-administered sections of the PARCA corresponded to scores from the Bayley Scales of Infant Development Mental Development Index in a sample of 107 two-year olds (BSID-II MDI; Bayley, 1993; \( r = .39, p < .001 \) & \( r = .27, p < .01 \) respectively; Saudino et al., 1998) and were also validated against the McCarthy Scales of Children’s Abilities (McCarthy, 1972; Oliver et al., 2002; Saudino et al., 1998). Furthermore, the PARCA-R (revised, with additional items) was validated against the BSID-II and BSID-III MDI in two samples (\( N = 64 \) and 204) of 24 month old preterm infants (\( r = .54, p < .001 \); Johnson et al., 2004; and \( r = .43, p < .001 \); Martin et al., 2013, respectively).

**Socioeconomic status (SES)**
Families reported three markers of SES via the online survey: (1) Educational attainment: Each parent stated the highest educational qualification they had obtained, ranging from school leaving certificate, national vocational qualification, undergraduate degree to postgraduate degree. (2) MacArthur Scale of Subjective Social Status (Adler, Epel, Casellazzo & Ickovics, 2000): The following instructions were displayed alongside a drawing of a ladder with 10 rungs “Think of this ladder as representing where people stand in our society. At the top of the ladder are the people who are the best off, those who have the most money, most education, and best jobs. At the bottom are the people who are the worst off, those who have the least money, least education, and worst jobs or no job.” Parents were asked to place an X on the rung that best represented their own SES, with 1 indicating low and 10 high SES. The MacArthur scale has previously been validated against a composite of income, education and occupation (\( r = .40, p < .01, N = 157 \); Adler et al., 2000), and a composite of education and occupation (\( r = .53, p < .01, N = 177 \); John-Henderson, Jacobs, Mendoza-Denton, & Francis, 2013). (3) Overcrowding index: Parents reported the number of people and the number of rooms in their household, excluding the bathroom, kitchen or box room (a small, often windowless room that is usually used for storage). An overcrowding index was calculated for each family by dividing the number of rooms in the home by the number of people in the household so that a higher score represented less overcrowding.

**Statistical analysis**
As our language measures were assessed at the family level, we also assessed literacy behaviors and beliefs at the family level rather than per parent. Thus, we summed mothers’ and fathers’ literacy behaviors in each family, and adjusted the sum by the number of parents who provided data.

We reverse-coded several literacy behavior items, including “How old was your child when you started to read to him or her?”, so that younger ages indicated higher literacy scores. We also reverse-coded two items from both the affect and the resources subscales, so that all scores indicated greater literacy behaviors. Next, we \( z \)-transformed each of the four literacy practices items, as they included open-ended responses and therefore standardizing these items allowed for comparison with the other literacy behavior items. For each of the literacy behavior domains (i.e. activities, practices,
and the belief subscales; affect, verbal, knowledge and resources), we calculated a mean average score per family.

Because the literacy belief subscales were highly inter-correlated (Table 2), we calculated a total literacy beliefs score per family by summing their average scores from each subscale (Table S1), which has also been done in other studies (Curenton & Justice, 2008; Weigel, Martin, & Bennett, 2006). Because the correlations between family-level literacy measures were high (details below) and to avoid issues of multicollinearity, a composite literacy index was built by z-transforming and summing the mean scores for literacy activities, practices and beliefs.

SES was indexed by three markers, educational attainment, subjective social status and an overcrowding index. The scores from each SES marker were z-transformed and summed, with the emerging index score being adjusted for the number of markers available per family (e.g., information from both parents). Regarding the PARCA booklet, one of our measures of children’s cognitive ability, composite scores for the three sections of the PARCA booklet (i.e., drawing, copying and matching), which correlated .33, .42, and .51, were calculated, z-transformed and summed. To evaluate the relative contributions of adult spoken language and parents’ literacy behaviors on children’s cognitive and language outcomes, we fitted separate regression models with SES, literacy index, adults’ word counts and adults’ lexical diversity as simultaneous predictors for the PARCA booklet scores, the PARCA parent report and children’s lexical diversity. These three outcomes were adjusted for child age and gender.

**Results**

The descriptive statistics for family level variables are displayed in Table 1 (see Table S1 for the descriptive statistics per parent, and Table S3 for raw PARCA booklet scores). Table 2 displays correlations between all study variables (see Table S2 for correlations per parent). The correlations between literacy activities, practices and beliefs ranged from .38 to .50, and we therefore built a composite score for all three measures, termed the literacy index (Table 2). The literacy index correlated moderately (i.e., .26 to .31) with children’s cognitive ability and lexical diversity, as did the number of adults’ words (i.e., .17 to .35) that children were exposed to. By comparison, adults’ lexical diversity was more weakly associated with children’s outcomes (i.e., –.02 to .28; Table 2).

The literacy index correlated .33 with adults’ word counts but was less strongly associated with adults’ lexical diversity (i.e., .06). There was no association between adults’ word counts and adults’ lexical diversity (i.e., –.01).

In the regression models (Table 3), the literacy index accounted independently for 4% and 5% of the variance in PARCA scores and parent-reported cognitive ability, although the regression model

| Table 1. Descriptive statistics of family-level variables. |
|-----------------------------|----------------|----------------|-----------------|----------------|
|                            | Mean           | SD             | Minimum         | Maximum        | α              |
| Literacy activities        | 4.15           | 0.67           | 2.19            | 6              | 0.59           |
| Literacy practices         | 0.01           | 0.51           | –2              | 1.3            | 0.66           |
| Literacy beliefs Affect    | 4.76           | 0.26           | 3.67            | 5              | 0.70           |
| Verbal                     | 4.08           | 0.48           | 2.4             | 5              | 0.62           |
| Knowledge                  | 4.41           | 0.33           | 3.4             | 5              | 0.61           |
| Resources                  | 4.61           | 0.61           | 1.5             | 5              | 0.05           |
| Total                      | 4.46           | 0.27           | 3.72            | 4.97           | 0.63           |
| Adults’ word counts        | 18021.70       | 5769.53        | 5533.08         | 33,441.89      | –              |
| Adults’ lexical diversity  | 46.05          | 13.78          | –8.79           | 74.04          | –              |
| SES index                  | −0.02          | 0.56           | –1.69           | 0.95           | –              |
| Children’s lexical diversity| 26.42          | 20.78          | –22.18          | 84.67          | –              |
| PARCA booklet              | 0              | 0.78           | −1.82           | 1.62           | 0.65           |
| PARCA parent report        | 19.46          | 3.3            | 12              | 27             | 0.72           |

Note. α = Cronbach’s alpha. Variables corrected for a recording duration, b number of available recordings. c N = 104.
Table 2. Pairwise correlations between family literacy measures and children’s outcomes.

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<tr>
<td>5. Literacy practices</td>
<td>.22</td>
<td>-.02</td>
<td>.19</td>
<td>.45*</td>
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<tr>
<td>6. Affect</td>
<td>.23</td>
<td>-.05</td>
<td>.04</td>
<td>.35</td>
<td>.30</td>
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<td>7. Verbal</td>
<td>.21</td>
<td>.12</td>
<td>-.03</td>
<td>.44*</td>
<td>.32</td>
<td>.40*</td>
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<tr>
<td>8. Knowledge</td>
<td>.27</td>
<td>.04</td>
<td>.12</td>
<td>.43*</td>
<td>.28</td>
<td>.44**</td>
<td>.48**</td>
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<td>9. Resources</td>
<td>.26</td>
<td>.18</td>
<td>.06</td>
<td>.11</td>
<td>.10</td>
<td>.19</td>
<td>.03</td>
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<td>10. Total</td>
<td>.34</td>
<td>-.10</td>
<td>.05</td>
<td>.50**</td>
<td>.38</td>
<td>.72***</td>
<td>.80***</td>
<td>.78***</td>
<td>.40</td>
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<td>11. Literacy index</td>
<td>.33</td>
<td>.06</td>
<td>.16</td>
<td>.82***</td>
<td>.77***</td>
<td>.57**</td>
<td>.65***</td>
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<td>.79***</td>
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<tr>
<td>12. Children’s lexical diversity</td>
<td>.17</td>
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<td>.24</td>
<td>.37</td>
<td>.20</td>
<td>.02*</td>
<td>.01*</td>
<td>.05*</td>
<td>.10</td>
<td>.05**</td>
<td>.26</td>
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<td>13. PARCA book</td>
<td>.35</td>
<td>-.02</td>
<td>.08</td>
<td>.30</td>
<td>.30</td>
<td>.09</td>
<td>.15</td>
<td>.08</td>
<td>-.02*</td>
<td>.13</td>
<td>.31</td>
<td>.46*</td>
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<td>-</td>
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<td>14. PARCA parent report</td>
<td>.13</td>
<td>-.15*</td>
<td>.07</td>
<td>.30</td>
<td>.24</td>
<td>.12</td>
<td>.04</td>
<td>.20</td>
<td>-.08*</td>
<td>.10</td>
<td>.27</td>
<td>.43*</td>
<td>.49**</td>
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<td>15. Child age</td>
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<td>-.14</td>
<td>-.06</td>
<td>.07</td>
<td>.17</td>
<td>.01</td>
<td>-.01</td>
<td>-.01</td>
<td>-.07*</td>
<td>-.02*</td>
<td>.09</td>
<td>.40*</td>
<td>.66***</td>
<td>.55***</td>
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</tbody>
</table>

Note. *p < .05, **p < .01, ***p < .001
for parent-reported cognitive ability did not reach significance \((p = .08)\). The literacy index did not account for any variance in children’s lexical diversity. The number of adults’ words was associated with the PARCA scores, accounting for 11% of the variance, but not with parent-reported cognitive ability or children’s lexical diversity. By contrast, adults’ lexical diversity explained 12% of the variance in children’s lexical diversity but was not related to either the PARCA scores or parent-reported cognitive ability. Finally, SES accounted for 4% of the variance in children’s lexical diversity but was not associated with either the PARCA scores or parent-reported cognitive ability.

Overall, our results show that the literacy index was moderately associated with the quantity of adult spoken language that children are exposed to and independently predicted children’s cognitive ability. In addition, we found that the quantity of adult spoken language predicted children’s cognitive outcomes, whereas the lexical diversity of adult spoken language predicted their language outcomes.

**Discussion**

We sought to compare the influence of parents’ literacy behaviors and beliefs with the quantity and lexical diversity of adult spoken language on children’s cognitive and language outcomes using data from naturalistic home observations. The key finding from this study is that parents’ literacy behaviors and beliefs were moderately, positively associated with the quantity of adult spoken language, suggesting that parents who expose children to more adult words also engage in more literacy behaviors and hold stronger literacy beliefs. Furthermore, we observed that parents’ literacy behaviors and beliefs predicted children’s cognitive outcomes, independent of the adult spoken language that children experienced in the family home. That said, adult spoken language accounted for almost three times more of the variance in children’s cognitive outcomes than parents’ literacy behaviors and beliefs did (i.e., 11% compared to 4%). Regarding this difference in effect size, spontaneous adult spoken language is a daylong endeavor, whereas parents’ literacy behaviors only occur for relatively short periods of time during the day. Thus, it is plausible that adult spoken language has a more pronounced influence on children’s cognitive outcomes than parents’ literacy behaviors and beliefs.

We are the first to report associations between parents’ literacy behaviors and beliefs, and everyday naturalistic adult spoken language in the home environment. We hypothesized that the quantity and lexical diversity of adult spoken language would be positively associated with parents’ literacy behaviors and beliefs.Confirming our first hypothesis, we found a moderate, positive association between parents’ literacy behaviors and beliefs and the quantity of adult spoken language. This association may be due to a common cause, for example because well-educated professional parents tend to speak more with their children and also engage in more literacy behaviors (cf. Korat & Haglili, 2007; Topping et al., 2013). However, we found no association between parents’ literacy behaviors and beliefs, and the diversity of adult spoken language that children were exposed to during everyday conversations. This finding suggest that parents’ literacy behaviors and adults’

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**Table 3. Regression models for children’s outcomes.**

<table>
<thead>
<tr>
<th></th>
<th>PARCA book(^a)</th>
<th>PARCA parent report(^c)</th>
<th>Children’s lexical diversity(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(B)</td>
<td>(SE)</td>
<td>(\beta)</td>
</tr>
<tr>
<td>SES index</td>
<td>0.02</td>
<td>0.17</td>
<td>0.01</td>
</tr>
<tr>
<td>Literacy index</td>
<td>0.09</td>
<td>0.04</td>
<td>0.20</td>
</tr>
<tr>
<td>Adults’ word counts(^a)</td>
<td>0.14</td>
<td>0.04</td>
<td>0.33</td>
</tr>
<tr>
<td>Adults’ lexical diversity(^b)</td>
<td>0.10</td>
<td>0.09</td>
<td>0.10</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.18</td>
<td></td>
<td></td>
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<tr>
<td>(F)</td>
<td>6.49</td>
<td></td>
<td></td>
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<tr>
<td>(p)</td>
<td>&lt;.001</td>
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Note. Variables corrected for \(^a\) recording duration, \(^b\) number of available recordings, \(^c\) age and gender. \(^d\) \(N = 104\). Predictors significant at \(p < .05\) are shown in bold.
lexical diversity are independent markers of the home language environment and not just proxies for the same construct.

Although parents’ literacy behaviors were associated with the quantity of adult spoken language, no associations were found with adults’ lexical diversity which may result from differences in the lengths of observation. The quantity of adult spoken language was measured over the course of 3 full days, whereas the assessment of adults’ lexical diversity was based on six 5-minute recording excerpts (i.e., 30 minutes per family). Although previous studies suggest that adults use more diverse language when engaging in literacy-related behaviors (Mol et al., 2008; Saracho, 2017), we found no relationship between the lexical diversity of everyday adult spoken language in a family and parents’ literacy behaviors and beliefs. It is possible that the positive effect of literacy behaviors and beliefs on adults’ lexical diversity is limited to the times when adults are actively engaged in literacy, rather than resulting in a systematic long-term increase of adults’ lexical diversity. However, our study design did not allow testing this hypothesis.

In their review, Head Zauche et al. (2016) question whether literacy behaviors and beliefs uniquely predict children’s language and cognitive outcomes, or if adult spoken language confounds and accounts for these associations. We found here, in line with our second hypothesis, that parents’ literacy behaviors and beliefs were unique predictors of children’s cognitive outcomes, independent of the everyday adult spoken language that occurred in the family home. It has been suggested that parents who exhibit literacy behaviors and beliefs ask their children more open-ended, complex questions during literacy activities that encourage the child to solve problems and develop their cognitive skills (Rodriguez et al., 2009; Saracho, 2017). Furthermore, literacy behaviors expose children to concepts rarely encountered in everyday life and therefore stimulates understanding of the semantic relations between things. Our findings are aligned with the neuroconstructivist theory of brain development, which posits the dynamic interplay between experience and neural networks that results in improved cognitive performance (Westermann, Thomas, & Karmiloff-Smith, 2010).

Unlike previous research (Deckner et al., 2006; Quach et al., 2018), we found no association between parents’ literacy behaviors and beliefs and children’s language outcomes. This discrepancy in findings might be due to two reasons. First, our assessment of parents’ literacy behaviors and beliefs was more comprehensive than in other studies that solely focused on shared book reading. Second, it is plausible that measuring children’s receptive rather than expressive language will result in stronger associations with literacy behaviors, although the aforementioned studies contradict each other on this point. Alternatively, it is also plausible that measures of child language development that assess children’s syntax rather than their vocabulary ability may show associations with parental literacy behaviors and beliefs.

In line with previous studies (e.g., Caskey et al., 2014; Gilkerson et al., 2018; Hart & Risley, 1995), we found that the quantity of adult spoken language was associated with children’s cognitive ability, at least when assessed by the PARCA booklet but not when the parents reported on their offspring’s cognitive abilities. The correlation between parent reports and children’s booklet test scores was .49 in the current study, which is comparable to .40 reported in previous studies (e.g., Saudino et al., 1998), suggesting that our assessment of children’s cognitive ability was reliable. However, parents are likely to be more biased in rating their child’s cognitive ability compared to the PARCA booklet, which objectively captures a child’s performance level.

In line with some previous studies but not others (Gilkerson et al., 2018; Greenwood, Thiemann-Bourque, Walker, Buzhardt, & Gilkerson, 2011; Pan et al., 2005; Ramírez-Esparza, García-Sierra, & Kuhl, 2014; Zimmerman et al., 2009), we found no association between the quantity of adult spoken language and children’s language outcomes. This may be because we did not differentiate between child-directed and overheard speech, although previous research has highlighted the importance of child-directed speech in language learning (Ramírez-Esparza et al., 2014; Rowe, 2012).

Our third hypothesis stated that the quantity and lexical diversity of adult spoken language will be more strongly associated with children’s cognitive and language outcomes than parents’ literacy behaviors and beliefs. We did find this to be the case, which may be due to the length of time that
families spend engaging in conversations compared with literacy behaviors. Notwithstanding, we found evidence that parents’ literacy behaviors are independently associated with children’s cognitive ability, suggesting that they may be a good target for interventions (Noble et al., 2018).

**Limitations**

Our study has many strengths but also some limitations. First, our measure of literacy behaviors was derived from parental reports and as such may be biased. We implore future studies to assess parental literacy behaviors from naturalistic observations, although this method will not allow assessment of the literacy beliefs that drive literacy behaviors (Bingham, 2007). Second, our measure of the quantity of adult spoken language neither differentiates parents from other adults, nor overheard from child-directed spoken language. That said, our measure assessed all adult spoken words that children are exposed to throughout the day and thus, comprehensively reflects children’s natural language environments. Third, our sample had a restricted SES range and therefore, it was not representative of the general population. However, associations between adult spoken language and parental literacy behaviors with children’s outcomes should exist regardless of SES, although we encourage future research to sample more diverse families. Fourth, our cross-sectional design precludes inferring causality or directionality. Longitudinal studies are needed to clarify whether, for example, more intelligent children evoke more literacy behaviors from their parents or vice versa.

**Conclusions**

For the first time, we compared the influence of parents’ literacy behaviors and beliefs, and adult spoken language on children’s cognitive and language outcomes in data from unobtrusive daylong naturalistic audio-recordings. We found positive associations between adult spoken language and children’s cognitive and language outcomes. Furthermore, we showed that parents’ literacy behaviors accounted for a significant proportion of the variance in children’s cognitive outcomes, independent of the adult spoken language in the family home.

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**Conflict of interest statement**

The authors do not have any conflict of interest.

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**ORCID**

Katrina d’Apice  [http://orcid.org/0000-0002-2117-9498](http://orcid.org/0000-0002-2117-9498)
Sophie von Stumm  [http://orcid.org/0000-0002-0447-5471](http://orcid.org/0000-0002-0447-5471)

**References**


