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**Examining the relations between early language skills and environmental variables and literacy skills: A longitudinal study from 2 to 9 years**

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### *Abstract*

A seven-year longitudinal study was conducted as part of the French national cohort ELFE ( $N = 1095$ ). The aim was to identify how and why early language skills at 2 years might predict later literacy skills assessed successively at 5, 7, and 9 years (LitSk5y; 7y; 9y). Using one and the same model, we also examined the relations between literacy skills in the three sessions and the potential impact of three environmental variables: the home learning environment (HLE) and two variables related to socioeconomic status (SES), namely parental education level (PEL) and household income (HInc). The main findings reveal that expressive vocabulary at 2 years is a significant predictor of LitSk5y. No significant link was found for HLE. The other significant links reveal that PEL is associated with LitSk5y and LitSk7y, and HInc with LitSk5y and LitSk9y. The differential impact of these two SES variables is discussed. Moreover, the Restructuring Lexical Model is proposed to explain how the development of early expressive vocabulary is linked to the development of literacy skills via an implicit stimulation of phonemic awareness during the acquisition of new words.

## **Introduction**

### **Early Linguistic Skills as Predictors of Literacy**

The acquisition of the early lexical skills is an important linguistic milestone during the second year of life. Indeed, children's language acquisition influences that of numerous skills during development, and particularly later reading ability (Nation & Snowling, 2004; NICHD, 2005; Scarborough, 2001). Generally, lexical skills have been measured using the MacArthur-Bates Communicative Development Inventories (CDI) at 1;6 and 2;0 years. The CDI is a

parent report instrument which captures important information about children's developing early language abilities, including vocabulary comprehension, production, gestures, and grammar. The validity and reliability of this norm-referenced instrument have been documented in many studies (Fenson et al., 2007; Law & Roy, 2008). The CDI has been adapted into more than 60 languages.

Numerous studies have shown that the size of the early expressive lexicon, measured using the long version of the CDI, is associated with pre-literacy skills at age five and with literacy skills up to age 16 (Bleses et al., 2016; Lee, 2011; Psyridou et al., 2018; Torppa et al., 2010). Can et al. (2013) have shown that the short-form CDI (see Fenson et al., 2000) can also be used to predict language and early literacy four years later. More recently, Vehkavuori et al. (2021) found a continuity between early receptive and expressive lexical skills measured with the short-form CDI and lexical, phonological, morphological and pre-literacy skills at 5;0 years.

However, some studies suggest that vocabulary knowledge, when measured on the basis of parental report before age 2, is not a very strong predictor of literacy outcomes. Thus, for example, Duff et al. (2015) studied the links between very early vocabulary and later literacy and showed that even when there is a significant link between early language and subsequent measures made when entering school, this relationship is weak. More specifically, they showed that early vocabulary accounts for 10% in reading accuracy and 18% in reading comprehension. As far as vocabulary at 2 years is concerned, Lee (2011) found that this explained 5% of reading accuracy and 7% of reading comprehension assessed between first and fifth grades. Although these studies show that infant vocabulary is a statistically significant predictor of later outcomes, it is also important to consider the size of these effects in order to avoid overinterpreting statistically significant but small effects (Paul & Roth, 2011).

In this paper, children's early linguistic skills were reported by parents at 2 years based on the French short-form version of the CDI (Bovet et al., 2005). The aim of this study was to investigate the longitudinal associations between early lexical ability at the end of the second year of life and literacy skills at the age of five, seven and nine. Moreover, the expected impact of environmental variables was also included in the analyses to allow us to examine this issue more precisely.

### **The Impact of Environmental Variables on Language Skills and Literacy Skills**

Two important variables are presented here as having an undeniable impact on literacy skills: the home learning environment (HLE) and the parental socio-economic status (SES). Indeed, during the first years of life, children spend a large part of their time at home with their parents.

Numerous studies have provided empirical evidence that the HLE is an important predictor of differences in children's academic and social development (Rose et al., 2018; Tamis-LeMonda et al., 2019). However, the definition and assessment of HLE varies from study to study (Lehrl et al., 2020). Thus, in some studies, HLE is defined as the three-way interactions between children, parents and text that take place at home (Hamilton et al., 2016). In other studies, three main features of HLE have been shown support children's educational development (Bradley & Corwyn, 2002): the children's participation in learning activities, the quality of parent-child interactions and the availability of learning materials. Finally, two constructs can be found for this domain: on the one hand, so-called home literacy practices (HLP) and, on the other, the so-called home learning environment (HLE), which is a broader concept that subsumes the first.

Sénéchal et al. (1998) proposed a model of home literacy in which they distinguish between two types of HLP, one focused on phonological and orthographic knowledge (so-called

"formal" or "code-focused") and the other focused on sharing the meaning of spoken or written language (so-called "informal" or "meaning-oriented"). Thus, according to this model, formal and informal activities have different relations to children's code and oral language skills. However, while some studies have corroborated the model (Hood et al., 2008; Manolitis et al., 2013; Skwarchuk et al., 2014), others have failed to replicate the specific pathways of the two types of HLP (Kalia & Reese, 2009; Kim, 2009; Manolitsis et al., 2011). Some studies have shown that informal activities, of which shared reading is prototypical, predicted either both oral language and coding abilities (Kalia & Reese, 2009) or, in certain cases, only coding skills (Sparks & Reese, 2012). When children have acquired the alphabetic principle, shared reading can facilitate the acquisition of code-based literacy skills (Mol & Bus, 2011). Moreover, some formal activities, such as naming letters, are often included among the informal activities, such as shared book reading. Thus, the difference between informal and formal literacy activities is not always very clear and these two types of HLP should be considered as complementary rather than distinct. Given that there is no consensus on the interrelationships between spoken language, coding skills and phonological awareness, many authors emphasize the importance of oral language skills in any literacy learning process (Dickinson et al., 2013; Kendeou et al., 2009; Stephenson et al., 2008).

Compared to HLP, HLE thus appears to be an "umbrella term" (Hamilton et al. 2016). In fact, HLE is comprised of many playful activities that support early development. It generally involves learning experiences, with access to different resources (e.g., books) and positive parental attitudes toward learning (e.g., shared reading) (Soto-Calvo et al., 2020; Lorio et al., 2022). Much research has focused on the role of the HLE in the acquisition of academic skills, such as literacy (Evans et al., 2000; Hartas, 2011; Sénéchal & LeFèvre, 2002). There is evidence that the quantity and quality of language input that is not focused solely on literacy activities also impact language development (e.g., Weisleder & Fernald, 2013) involving

aspects other than those related specifically and directly to literacy (Goodrich et al., 2021). For example, shared drawing activities help stimulate language skills. When children draw in the presence of their parents, they converse about their drawings. Einarsdottir et al. (2009) report several studies where children have been encouraged to draw and have pointed out the importance of drawing as a communicative rather than just a production process. More specifically, they indicate that when children draw and talk, they construct and convey meaning. Shared music activities have rarely been addressed separately as an important component of the HLE in the research to date and have instead typically been grouped together with other home learning practices (Hartas, 2011). Recently, Hoyne and Egan (2022) showed that shared book reading and activities involving singing songs, playing games, and engaging children in drawing contributed independently to expressive vocabulary scores. In this study, we will calculate an overall score including different activities such as shared book reading, shared drawing activities, shared singing activities, telling stories and copying letters, thus providing an indicator of HLE and its relationship to later literacy skills.

With regard to the second environmental variable, parental socioeconomic status (SES) is generally indexed by household income and parental education. Much research has shown that SES is linked to children's literacy skills (Fernald et al., 2013; Gonzalez et al., 2017; Huttenlocher et al., 2010; Pace et al., 2017). Studies have shown that children from families with low SES tend to have fewer books and read less frequently than those from higher SES families (Burgess et al., 2002; Crosnoe et al., 2010; Niklas et al., 2020); this difference results in children from higher SES families achieving higher performances in vocabulary, oral language and emergent literacy skills (Farver et al., 2013; Froiland et al., 2014; Mol & Bus, 2011). Moreover, several authors have shown that parents who have a high education level provide family environments that are enriched in terms of literacy, have more positive

attitudes toward shared reading and, therefore, have a positive influence on the development of their children's language and literacy skills (Lonigan, 2004; Umek, et al., 2005).

While many studies have considered the family's SES to comprise both the parents' educational level and the family income, few studies have directly compared the separate unique roles of the parents' educational level and household income. However, some authors (i.e., Davis-Kean, 2005; Zheng & Libertus 2018) have suggested that parents' education and household income play different roles in determining parents' beliefs about the importance of school and parenting behavior at home in teaching math or reading/writing to their children. In our study, we will distinguish between these two variables and examine their respective effects on later literacy skills.

### **Research Questions**

Our first aim in this seven-year longitudinal study was to examine the links between literacy performance assessed in three successive sessions, namely at five, seven and nine years. We then extended the analysis of literacy skills development by including four variables, one early language skill (expressive vocabulary) and three environmental variables (home learning environment, parents' educational level and household income) which are thought to be linked to literacy skills. We expected all these variables to have an impact on the development of literacy skills.

### **Method**

#### **Participants**

The participants in this study were children from the French national cohort ELFE (Etude Longitudinale de l'Enfance en France; see Charles et al., 2020) born in 2011. Data concerning different variables were collected during interviews conducted by an investigator with the parents or with the child at home, and those concerning literacy skills were collected at school



by teachers during three sessions, i.e., when children were in preschool in April-June 2016 (in their 5<sup>th</sup> year; 5y), in grade 1 (April-June 2018; 7y) and in September-December 2020<sup>1</sup> at the beginning of grade 4 (9y). Finally, this longitudinal study is based on data from 1095 children (581 girls, 514 boys; mean age in preschool: 57.6 months; sd = 2.79) and no literacy skills data are missing for any of the sessions. No children diagnosed as disabled by a psychologist were included in this study.

Two indicators were used to determine the family socio-economic status, namely parent's educational level (PEL) and household income (HIInc) (see below). We observe that attrition during the study primarily affected low socio-economic families. At the start of the study, 13.88% of the original sample of 10,830 children were from families in the two lowest PEL brackets, whereas only 6.95% of the remaining sample of 1095 were from the same PEL group nine years later (see Appendix A).

### **Expressive vocabulary**

*Communicative Development Inventories (CDI2y)*. We used an adapted French version of the MacArthur-Bates Communicative Development Inventories (Bovet et al., 2005). A list of 110 words was presented and the parents had to say whether their child spontaneously produced these words.

### **Literacy skills**

Two dimensions of literacy were investigated during each session: the so-called code-related skills dimension and the meaning-related skills dimension. Teachers administered the tasks in

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<sup>1</sup> Collection of this data had initially been planned for spring 2020 (grade 3) but was postponed until the fall because of the COVID-19 pandemic.

small groups during the three sessions<sup>2</sup>. Children had a booklet in which they gave their answers.

*Literacy skills (LitSk5y)*. Four tasks were used for three domains (see Ecalle et al. 2020). In the letter-name knowledge task (/10), children had to choose the named letter among 7 possible options. Phonological skills (/15) were assessed using two tasks: in the oddity task, the teacher named three pictures and the children had to circle the one which did not share a common unit, i.e., a syllable or phoneme (/9); in the syllable deletion task, the teacher named all the pictures, i.e., a first word [e. g., *bijou* (jewel) and then the four test words *joue* (cheek), *genou* (knee), *couronne* (crown), *cœur* (heart)] and the children had to retrieve a new pictured word (*joue*) after deleting the first syllable of the first word (/6). For vocabulary (/10), a classical task was presented and the children had to identify which of four pictures corresponded to an orally presented word. LitSk5y: max = 35.

*Literacy skills (LitSk7y)*. Children were evaluated with four tasks (see Ecalle et al., 2023). In the phonemic awareness task (/10), the children had to draw the same number of circles as the number of phonemes heard in a pseudoword spoken by the teacher. To assess word reading (/14), they had to circle the word corresponding to a spoken word among five test items consisting of words (*mouton*; *mouture*) and pseudowords (*mauton*; *moutton*; *mtonou*). To assess listening comprehension (/9), the children first listened to a short text (136 words) read twice by the teacher and then had to respond to oral questions by circling a picture among four test items. In reading comprehension (/12), the children read a narrative text (111 words)

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<sup>2</sup> One constraint was that the teachers could not evaluate the ELFE cohort children alone in their classrooms, but instead had to do so in groups of 1 to 3 children from the same class and of approximately the same age.

silently and on their own and then had to respond to written questions by selecting a response from among 4 pictured test items. *Litsk7y*: max = 45.

*Literacy skills (LitSk9y)*. Three domains were assessed. Fluency (/40): children had to read a pair of items (word and pseudoword) to themselves and then had to say if they sounded the same (silence - silense: yes) or not (pulbic – public: no); they had one minute to give as many responses as possible. In the listening comprehension task (/12), the teacher read a pair of sentences and children had to say whether the two sentences had the same (or very similar) meanings or whether the meanings of the two sentences were very different (see Ecalle et al., 2013). The reading comprehension task (/12) was similar to the one proposed in the previous session but with a more complex text. *LitSk9y*: max = 64.

### **Environmental Variables**

These variables were collected during the fifth year either by means of a phone interview or by an investigator who visited the family's home.

*Home learning environment (HLE5y)*. We asked eight questions about literacy skills or skills associated with literacy, to which the mother responded yes or no. Examples of such questions include: Do you tell stories to your child? Do you sing or listen to music with him/her? Do you ask him/her to recite the alphabet or spell words? Do you draw with him/her? (max = 8).

*Parent educational level (PEL5y)*. The International Standard Classification of Education (UNESCO, 2012) was used to classify the educational levels of the mothers. We distinguished six levels from lower secondary general education (n = 20) to upper secondary general education (n = 56), to bachelor's degree (n = 144), then two years after bachelor's degree (n = 270), three-four years after bachelor's degree (n = 282), and finally five or more years after bachelor's degree (n = 323).

*Household income (HInc5y)*. This variable refers to the total household income indicated by the referent parent and the number of members living in the household dwelling (and their ages). These values made it possible to calculate a more specific level of HInc, with income weighted by the number of consumption units for each household with an ELFE child. For the purposes of our analysis, we subdivided the HInc into quintiles.

The Table (Appendix B) with household income at 5 years in quintiles and parent educational level (at 5 years) in six categories indicates a significant link between these two variables (Kendall's  $\tau = .38$ ;  $\chi^2 = 303.77$ ;  $p < .001$ ).

## Results

After presenting the descriptive data and a correlation matrix, we indicate the results of structural equation modeling to examine the links between the language skills and environmental variables and the literacy skills at the three sessions. Supplementary analyses were conducted for significant covariates with literacy skills.

### Descriptive data

Table 1

*Descriptive data (N=1095) for language skills, literacy skills and environmental variables*

task	mean	sd	min/max	$\alpha$	Skew	Kurt
Language skills						
CDI2y	76.06	23.09	2/100	.98	-1.21	3.97
Literacy skills 5y						
LNK	7.75	2.69	0/10	.86	-1.16	3.28
PhoS	8.79	3.55	0/15	.77	-.33	2.53

Voc	7.81	1.83	0/10	.62	-1.21	4.66
LitSk5y	24.35	6.04	3/35		-.64	3
<hr/>						
Literacy skills 7y						
PA	7.91	2.47	1/10	.82	-1.12	3.22
WR	9	2.87	1/14	.69	-.29	2.47
LC	7.86	1.3	0/9	.58	-1.42	6.39
RC	7.63	2.89	0/12	.77	-.64	2.86
LitSk7y	32.4	6.39	11/45		-.42	2.72
<hr/>						
Literacy skills 9y						
Flu	20.75	11.24	0/40	.81	.48	1.8
LC	9.93	1.72	1/12	.55	-.94	3.94
RC	10.25	1.73	0/12	.66	-1.78	6.96
LitSk9y	40.93	11.9	14/64		.37	1.99
<hr/>						
Environmental variable 5y						
HLE	6.96	1.18	2/8	.60	-1.33	4.65

Notes. A: Cronbach's alpha; <sup>a</sup>: calculated on raw scores; CDI: Communicative Development Inventories; LNK: letter-name knowledge; PhoSk: phonological skills; Voc: vocabulary; LitSk: literacy skills; PA: phonemic awareness; WR: word recognition; LC: listening comprehension; RC: reading comprehension; Flu: fluency; HLE: home learning environment; Skew: skewness; Kurt: kurtosis.

Table 2

Correlation matrix ( $N = 1095$ ) for language skills, literacy skills and environmental variables

	CDI2y	HLE5y	PEL5y	HIInc5y	LitSk5y	LitSk7y
HLE5y	.12***					

PEL5y	.12***	-.04				
HInc5y	.08**	.00	.45***			
LitSk5y	.25***	.09***	.20***	.17***		
LitSk7y	.23***	.07*	.21***	.17***	.40***	
LitSk9y	.08**	.00	.15***	.09**	.21***	.28***

Notes. CDI: Communicative Development Inventories; LitSk: literacy skills; PA: phonemic awareness; WR: word recognition; LC: listening comprehension; RC: reading comprehension; Flu: fluency; HLE: home learning environment; PEL: parents' educational level; HInc: household income; \*\*\*:  $p < .001$ ; \*\*:  $p < .01$ ; \*:  $p < .05$ .

### What are the Links Between Literacy Skills and Linguistic and Environmental Variables?

To examine this question, we performed structural equation modeling analyses (using Stata18), linking the literacy skills at the three sessions with each other as well as with four covariates: expressive vocabulary assessed at 2 years (CDI2y) and the environmental variables of home learning environment (HLE5y), household income (HInc5y) and parents' educational level (PEL5y). In the light of the significant departures from normality (see skewness in Table 1), we ran analyses using the Satorra-Bentler estimator.

We then examined the model fit indices. Several criteria have to be met (see Schreiber et al., 2006): values  $> 0.90$  for the comparative fit indices (CFI) and Tucker–Lewis (TLI) are expected, and values lower than 0.08 for the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR) are advisable

We present the model in Figure 1 with the following goodness of fit: CFI = .935; TLI = .908; RMSEA = .038; SRMR = .03. Supplementary data for standardized and unstandardized loadings for each path included in the model are provided in Appendix C.

At the level of the structural model, we observe that LitSk5y is significantly linked to LitSk7y, which is itself significantly linked to LitSk9y. However, no significant link is found between LitSk5y and LitSk9y. For the covariates, CDI2y is significantly associated with LitSk5y. HLE5y is not significantly ( $p = .067$ ) linked to LitSk5y or to LitSk7y and LitSk9y ( $p > .10$ ). PEL5y is significantly related to LitSk5y and LitSk7y, but not to LitSk9y. Finally, HInc5y is also linked to LitSk5y and LitSk9y, but not to LitSk7y.

We completed our analyses using PEL5y as the environmental variable in order to examine its weight on other variables. Given the moderate correlation between PEL and HInc, it would have been redundant to conduct the same type of Anova with HInc.

### **What Are the Specific Effects of PEL on Vocabulary and Literacy Skills and Home Learning Environment?**

We will consider the effect of PEL on literacy skills at the three sessions, as well as on CDI2y, the first language skills of interest, and HLE. We first distinguished between three levels (in fact, there were too few children in the lowest PEL), the lowest (1 and 2;  $n = 76$ ), the middle (3-4;  $n = 414$ ) and the highest (5-6;  $n = 605$ ). One-way ANOVAs were run with PEL as between-subjects variable and the z-scores<sup>3</sup> as dependent variables.

All ANOVAs were significant except for the one run on HLE: for LitSk5y:  $F(2,1092) = 28.76, p < .0001, \eta_p^2 = .05$ ; for LitSk7y:  $F(2,1092) = 35.22, p < .0001, \eta_p^2 = .06$ ; for LitSk9y:  $F(2,1092) = 12.19, p = .0001, \eta_p^2 = .02$ ; for CDI2y:  $F(2,1092) = 5.5, p < .004, \eta_p^2 = .01$ .

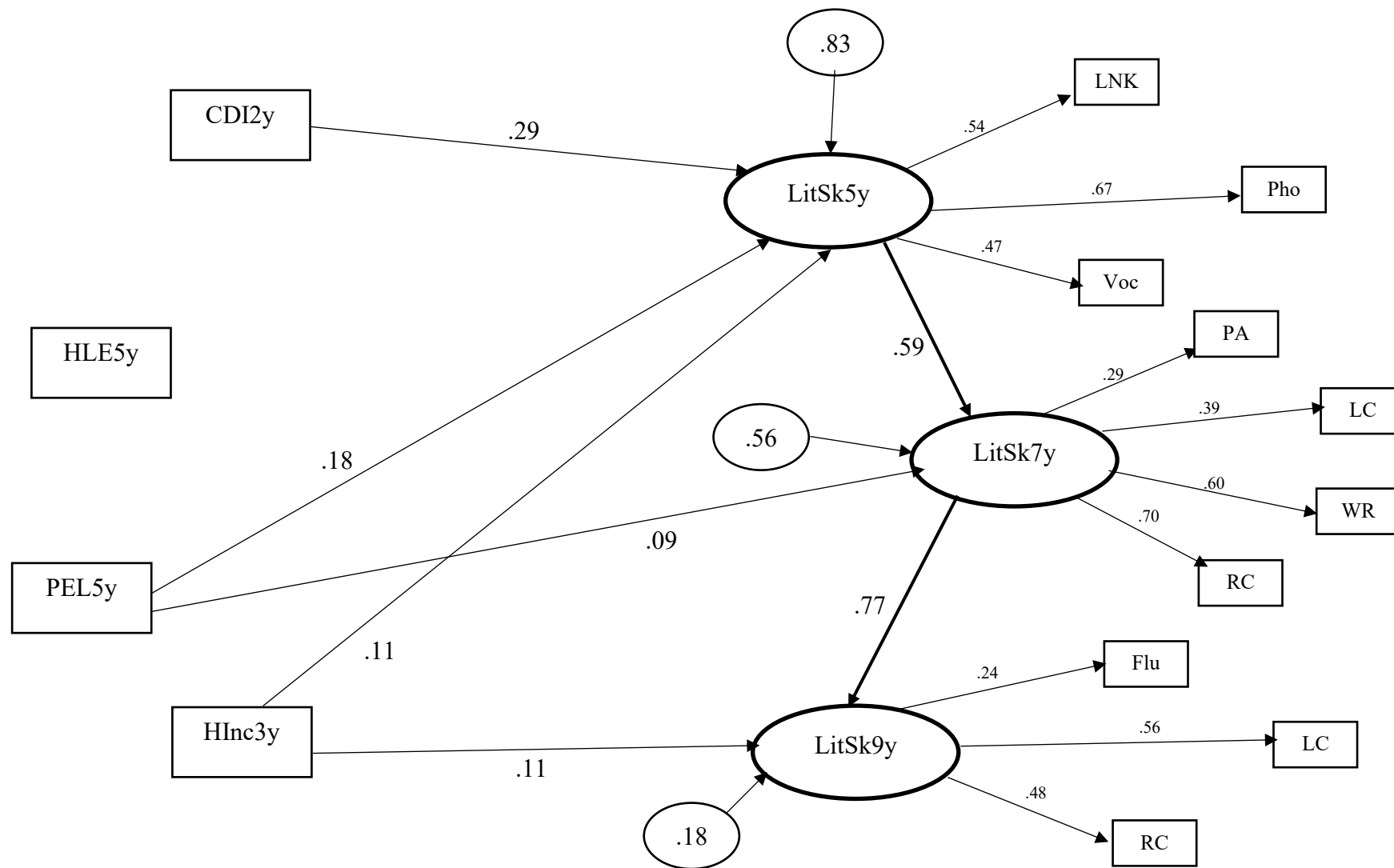
Results are presented in Figure 2. We clearly observe that performance increases with increasing PEL and that scores for PEL1 (and PEL2 for Litsk7y) are below the general mean.

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<sup>3</sup> Due to the overrepresentation of high socio-economic classes without missing data in our sample ( $N = 1095$ ), we computed z-scores based on larger numbers (Appendix D).

Figure 1

Structural equation modelling with covariates (with only significant standardized coefficients;  $p < .05$ )

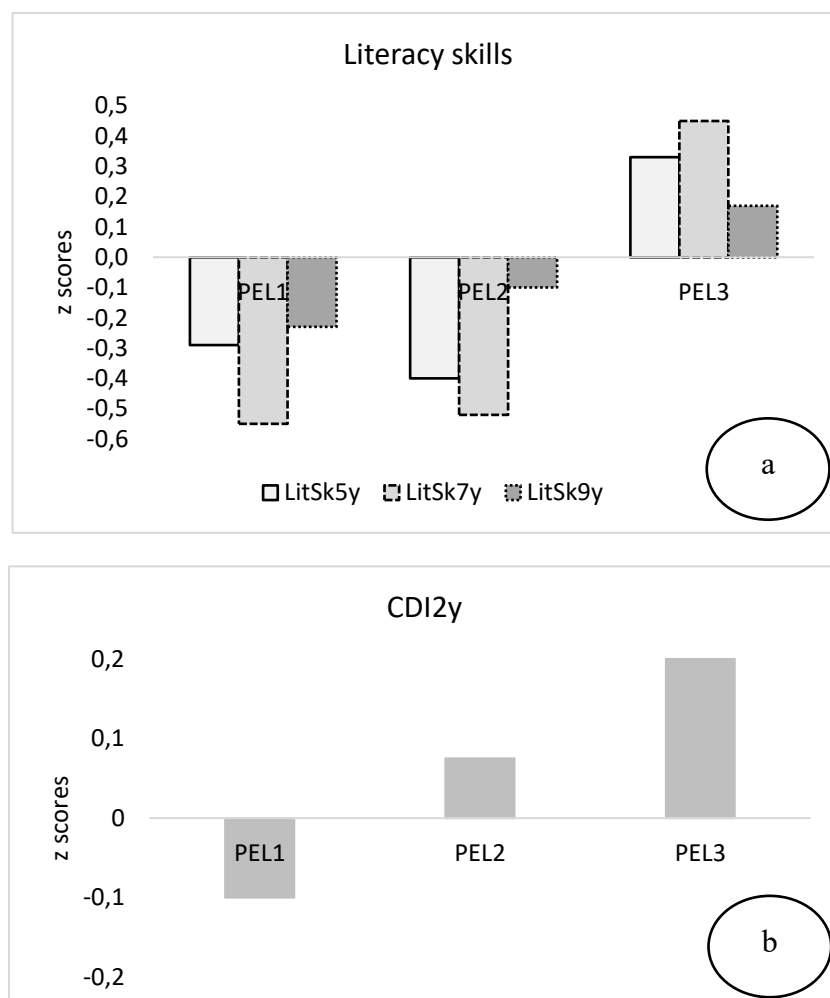




Notes. CDI: Communicative Development Inventories; LNK: letter-name knowledge; Pho: phonological skills; Voc: vocabulary; LitSk: literacy skills; PA: phonemic awareness; WR: word recognition; LC: listening comprehension; RC: reading comprehension; Flu: fluency; HLE: home learning environment; PEL: parents' educational level; HInc: household income; in circles, residual variance for latent variables.

Figure 2

Mean z-scores as a function of parents' educational level (from lowest to higher: PEL1, PEL2, PEL3) and literacy skills (LitSk) at 5, 7, 9 years (a), on the Communicative Development Inventories (CDI2y) (b)



## **Discussion**

Much research conducted in recent decades has examined the different predictors of later reading achievement during the first years of schooling (preschool and kindergarten). Other studies have focused on first language skills as predictors. Our results show that an early language skill assessed with the CDI, here the number of words that a child is able to use at 2 years, i.e. the child's expressive vocabulary, constitutes a significant predictor of literacy skills at 5 years.

### **Early Language Skills and Literacy Skills: An Explanatory Theory**

How can we explain why early expressive vocabulary is linked to early literacy skills?

Vocabulary develops under the influence of lexical representations and progressive lexical organization. The issue is: how are words stored and what are the processes involved?

According to the Lexical Restructuring Model (Metsala & Walley, 1998; Walley et al., 2003), vocabulary growth requires an increasingly fine-grained and more segmental representations of the words that children progressively acquire. To store new words, it is necessary to segment them more precisely at the level of the more fine-grained unit, the phoneme.

Distinguishing "pig" and "big" is implicitly based on the discrimination of two phonemes.

This restructuring process contributes to phonemic awareness, which is itself a predictor of reading ability. Metsala et al. (2009) experimentally tested this model and concluded that "spoken word representations are related to reading indirectly through phonological awareness" (p. 116).

After a short assessment session at 5 years involving only 35 items spread across four tasks (letter-name knowledge, two phonological tasks and vocabulary) we were able to obtain a proxy of first literacy skills as the foundation and predictor of later literacy skills, including reading tasks, at 7 and 9 years. Early expressive vocabulary can now be added as a new and

very early predictor of the first literacy skills. The Restructuring Lexical Model serves as a compelling explanatory theoretical support for the link between early lexical storage and later reading level.

### **Parental Education Level and Household Income: Two Important Environmental Factors**

If we turn our attention to three environmental variables which are expected to be associated with literacy skills, we observe that parents' educational level and household income are important factors impacting early language skills (expressive vocabulary) and later literacy skills, whereas the home environment learning is associated only with literacy skills at 5 years (see also Ecalle et al., 2023).

Although the scientific literature does not report many studies about the specific role of parents' education, on the one hand, and household income, on the other, there are nevertheless three studies in which this issue is addressed in more detail. Davis-Kean (2005) suggested a model in which parental educational expectations should be introduced as a mediating factor between parental education and family income, on the one hand, and academic achievement, on the other. In fact, in Davis-Kean's final model, the contribution of parental education to reading is greater (.23) than that of family income (.15). The author hypothesizes that "the parents' education influences child achievement indirectly through its impact on the parents' achievement beliefs and stimulating home behaviors" (Davis-Kean, 2005, p. 300). But the paper does not provide clear evidence that parents' expectations differ depending on whether the two variables are considered jointly or separately. Zheng and Libertus (2018), however, provide some answers to this issue. They show a specific effect of the two variables on parents' so-called "skill set beliefs" (about the importance of math and reading/writing at home or school). While they found no significant effects of parents'

education on skill set beliefs (home and school), they found a significant effect (only in African American parents) of household income on skill set beliefs about school but not home. These results highlight the differential impact of the two variables involved in socioeconomic status, i.e., parental educational level and household income. Our findings also reveal a difference, but, in the opposite direction, that is to say in favor of parents' education as was also found in the recent study conducted by Xia (2022). Using a direct model, this author showed that parental education is significantly related (.14) to the cognitive school readiness of children in kindergarten, whereas family income is not (.08). When mediating variables such as parental involvement and parenting style were introduced in a sequential model, there were no longer any significant links between the two socioeconomic status variables and school readiness.

Further research is needed to find out why there seems to be a difference between these two variables, one "educational" and the other "budget-related", which are, ultimately, distanced in terms of their psycho-sociological values. Moreover, what form does this difference take and how great is it? For example, what are the specific effects of these variables on parents' beliefs about the importance of their children's academic achievements and what are the potential mediating variables between these two socioeconomic variables and children's academic achievement? While it would be beneficial to investigate skill set beliefs again in more detail, parents' trust in school should also be considered.

### **Limitations**

The limitations of this study are related to the context, in which data was collected at various times at home and at school by different research teams (medical, demographical, sociological and psychological), meaning that the time available to evaluate the data was restricted for each team. Therefore, the domains investigated, the number of tasks and the number of items

in each task were also limited. For example, listening comprehension in preschool and reading fluency, rapid automatized naming and short-term verbal memory in Grade 1 could be added to the set of tested skills. Moreover, some tasks did not reach the .70 benchmark of Cronbach's values and this may somewhat weaken the results.

With regard to language skills at 2 years, the addition of the mean utterance length might have made it possible to obtain a better index of the "early language skills" variable. Another limitation is due to one of the drawbacks of longitudinal studies, namely the attrition phenomenon, which concerned the families with the lowest socioeconomic status in our sample. Other studies have also reported this phenomenon, which is essentially predicted by low household income and socioeconomic status of the mother (Schmidt & Woll, 2017), low educational level of the mother (Gustavson et al., 2012), and low socioeconomic status of the father (Cumming & Goldstein, 2016). It is to be expected that the loss of families with low socioeconomic status had an impact in terms of the statistical power of the environmental variables included in the analysis.

And finally, the examination of the home learning environment could have been supplemented by questions (using Likert scales) about the frequency of the activities, and also about other factors such as the number of children's books at home, the frequency of library visits with the child, etc.

### **Conclusion**

This long-term longitudinal study confirms that the development of literacy skills from 5 to 9 years seems to follow on from the first assessment at 5 years. Expressive vocabulary at 2 years is linked to subsequent literacy skills assessed three years later. This result is consistent with the Restructuring Lexical Model: the more the lexicon develops, the greater the need for a reorganization of the lexicon at the phonemic level. This restructuring contributes to

phonemic awareness, which is one of the most powerful predictors of reading. The parents' educational level and the household income seem to play a role in the development of literacy skills. Finally, the parents' educational level is linked to children's early vocabulary.

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### Appendix A

*Distribution of PEL in a large sample and in the sample used for the present study*

	<i>N</i> = 10830		<i>N</i> = 1095	
categories	count	%	count	%
1	429		20	
2	1074	13.88	56	6.95
3	1800		144	

4	2562	40.28	270	37.81
5	2308		282	
6	2657	45.84	323	55.25

### Appendix B

*Table with parents' educational level (PEL) and household income (HInc) for each category from lowest to highest PEL (1, 2, 3, 4, 5, 6) and from first quintile to fifth quintile for HInc (N = 1077).*

	PEL						
HInc5y	1	2	3	4	5	6	total

1	4	26	24	35	16	10	115
2	9	17	44	47	37	24	178
3	4	8	40	77	69	39	237
4	2	1	21	61	107	101	293
5	1	3	13	47	51	139	254
total	20	55	142	267	280	313	1077

*Notes.* PEL: parents' educational level; HInc5y: household income at 5 years.

### Appendix C

*Table with standardized and non standardized coefficients in the final structural model*

		coef. non stand.		coef. stand.	
		coef.	<i>p</i>	coef.	<i>p</i>
	CDI2y	.018	.000	.293	.000
LitSk5y	HLE5y	.093	.071	.076	.067

	PEL5y	.205	.000	.181	.000
	HInc5y	.118	.019	.105	.015
<hr/>					
	CDI2y	.002	.103	.067	.092
	HLE5y	.012	.560	.020	.560
LitSk7y	PEL5y	.052	.042	.094	.035
	HInc5y	.029	.205	.052	.202
	LitSk5y	.291	.000	.588	.000
<hr/>					
	CDI2y	.010	.097	.084	.088
	HLE5y	-.108	.236	-.047	.230
LitSk9y	PEL5y	.143	.169	.068	.157
	HInc5y	.217	.033	.105	.028
	LitSk5y	.144	.415	.078	.539
	LitSk7y	2.89	.000	.773	.000
<hr/>					

## Appendix D

*Data from larger samples for literacy skills, early language skills, and home learning environment*

	LitSk5y	LitSk7y	LitSk9y	CDI2y	HLE5y
	/35	/45	/64	/110	/8
count	12162	14470	2779	12471	3896
mean	23.42	30.23	40.44	67.67	6.93
st dev	6.35	7.98	12.14	15.76	1.16
<hr/>					

*Notes.* LitSk: literacy skills; CDI: Communicative Development Inventories; HLE: home learning environment.



