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Impact of parental reading skills and children's reading environment and interest at pre-school age on the vocabulary and reading skills in elementary school

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Das Ziel dieser Studie ist es, den Einfluss der mütterlichen und väterlichen Lesekompetenzen sowie des Leseumfelds von Kindern im Vorschulalter auf deren Wortschatz, Lesefertigkeiten und Textverständnis am Ende der Grundschule zu klären. Dazu wurden der rezeptive Wortschatz, die Leseflüssigkeit und weitere Lesekompetenzen von 91 Schulkindern erhoben und mit der elterlichen Lesekompetenz, dem sozioökonomischen Status und der non-verbalen Intelligenz sowie dem Leseumfeld ebendieser Kinder im Vorschulalter in Beziehung gesetzt. Die Resultate zeigen, dass das vorschulische Leseumfeld und der non-verbale IQ Prädiktoren des Wortschatzes von Kindern der 5. Klasse sind, und dass die Lesefertigkeiten der Eltern und das vorschulische Interesse an Büchern die Lesefertigkeiten der Kinder in der 5. Klasse vorhersagen. Diese Studie zeigt auf, welche Faktoren des vorschulischen Leseumfelds als Prädiktoren des Wortschatzes und der Lesekompetenzen am Ende der Primarschule besonders wichtig sind.

Stichwörter:
Wortschatz, Textverständnis, Lesekompetenz, Dekodierfähigkeit, vorschulisches Leseumfeld, elterliche Lesekompetenz, non-verbaler IQ, sozioökonomischer Status.

Keywords:
vocabulary, reading comprehension, reading fluency, decoding fluency, preschool literacy environment, parental reading level, non-verbal IQ, socioeconomic standard.

1. Introduction

The word is the central pillar of human language and communication because it conveys complete semantic and grammatical meaning. Vocabulary – the number of words an individual can recall (definition of the Cambridge dictionary (Cambridge University Press, 2014)) – plays an important role for a child's school and academic success, and is closely linked to general cognitive abilities (Biemiller 2006; Kievit et al. 2017; Lenhard & Lenhard 2021; Pace et al. 2019). Vocabulary has been recognised as a critical factor to promote learning in various domains, such as verbal concept formation, reading and also fluid intelligence skills (e.g. matrix reasoning) (Kievit et al. 2017). It is thereby essential not only for a successful scholastic career but also for children's overall cognitive and social development (Ebert et al. 2013). Young children's verbal

production begins around the age of one to one and a half. Between the age of one and a half and two years, children master about 50 words actively and have a receptive vocabulary of around 200 words (Kauschke 2021; Szagun 2006). Between the age of 2 and 6, vocabulary is massively boosted, such that at school onset, the beginning of literacy acquisition, the average receptive vocabulary consists of about 14,000 words, with extraordinarily wide variation among individuals (Clark 2009).

There is considerable evidence that home literacy environment (HLE) is an important predictor for children's literacy and language development (Frijters et al. 2000; Levy et al. 2006; Sénéchal & LeFevre 2002). HLE includes several formal and informal literacy activities such as shared parental reading, teaching the child how to write his or her name but also passive influences such as parental attitudes towards literacy or their literacy resources (e.g. number of books available at home) (Puglisi et al. 2017). A large part of early childhood vocabulary acquisition simply occurs through everyday language contact. Child-directed speech, storytelling and reading aloud by adult caregivers critically support children in this process (Clark 2009). Particularly the amount of child-directed speech has a considerable impact on the size of the expressive vocabulary in toddlers (Huttenlocher et al. 1991; Weisleder & Fernald 2013), and its further development (Rowe et al. 2012). The important contribution of shared reading on young children's vocabulary growth (Marulis & Neuman 2010) can be explained by the fact that storybooks contain up to 50% more words than are commonly used during TV shows, in everyday conversations or in child-directed speech (Hayes & Ahrens 1988). The benefits are further enhanced when shared reading or storytelling is structured as an interactive process (Vaahtoranta et al. 2019). Shared reading not only has a positive effect on vocabulary growth, but also on other literature related abilities, such as recognising letters, linking print to speech but also on learning how to handle a book (Bus et al. 1995). According to a meta-analysis, shared storybook reading of preschool children with their parents has, among other factors, an important positive effect on reading achievement independent of the socio-economic status of the family and is thus considered an important prerequisite for successful reading acquisition (Bus et al. 1995).

While shared reading is important for vocabulary development, vocabulary itself has a long-lasting impact on reading acquisition (Ouellette 2006; Sénéchal et al. 2006; Whitehurst & Lonigan 1998). It is an important predictor of several literacy-related abilities such as spelling, reading comprehension and accuracy (Fricke et al. 2009; Nation & Snowling 2004).

Moreover, vocabulary expands and enhances the phonological representation of words and sublexical items in the mental lexicon, thus fostering phonological awareness (Metsala 1999). Phonological awareness, for its part, is typically impaired in poor readers (Goswami 2000; Vellutino et al. 2004), which is why

promoting vocabulary through shared reading is particularly beneficial for these children. Accordingly, children with good reading skills and a rich vocabulary usually read more frequently, thereby learn the meaning of more words and consequently improve their reading skills even more (Stanovich 1986). Conversely this also means that the poor get poorer. This may be especially critical for those 3-11% of children suffering from developmental dyslexia (DD), a neurodevelopmental learning disorder characterised by severe impairments in reading and/or spelling (Galuschka & Schulte-Körne 2016). In a recent study of Snowling and colleagues (2020), more than a third of the children with DD showed impairments in vocabulary, which may at least partly stem from less reading experience. If, in addition, children with specific language impairments are taken into account, the proportion of those showing deficits in vocabulary increases to more than 80% (Snowling et al. 2020).

Yet, findings from studies on the role of HLE in children with specific language impairments or DD vary widely. While Skibbe and colleagues (2008) did not find any significant association between HLE and children's emerging reading skills, HLE was the only significant predictor of print knowledge after controlling for socio-economic status (SES) in the study of McGinty & Justice (2009). Importantly, HLE also showed a positive effect on vocabulary in children at risk for dyslexia (Caglar-Ryeng et al. 2020). A possible account for these inconsistencies is that the relation between HLE and children's literacy skills is mediated by genetic factors (Puglisi et al. 2017; van Bergen et al. 2017). A meta-analysis in twins estimated the heritability of reading at 73% and of reading comprehension at 49%. Environmental influences accounted only for around 10-13% of the variance in reading and reading comprehension (de Zeeuw et al. 2015). Slightly lower effects of heritability (57%) but similar effects of environment (13%) were reported for vocabulary (verbal IQ) (Rowe et al. 1999). Interestingly, the influence of heritability was especially high and environmental influences low in highly educated families. In families with lower educational background, the environmental influences increased (Rowe et al. 1999). However, the contribution of genetic and environmental contributions changes with increasing literacy skills and age (Samuelsson et al. 2007; Verhoef et al. 2021).

In the present study, we aimed to clarify how the HLE at preschool age impacts literacy development on the long-term in a sample of 91 native German-speaking school children coming from middle to high SES families, the majority having a moderate to high familial risk for developmental dyslexia. Specifically, we aimed to determine how the current reading performance of both parents, as well as HLE and literacy interests of the children at preschool age account for children's receptive vocabulary, reading fluency, decoding fluency and reading comprehension skills. The mothers of the children showed on average better performance in reading and decoding fluency skills than the fathers (see Table 1). To account for possible differences in the involvement and effect of

each parents' preschool reading activities with their children on children's later language performance, we recorded joint reading activities separately for each parent in our questionnaires. At the time of the study, children were attending the 5th grade of Swiss elementary school and were about 11 years old. In accordance with previous studies (Ebert et al. 2013), we expected to find a moderate impact of children's HLE on the long-term outcome of vocabulary skills and a strong familial transmission of reading skills shown by a strong association of parents' and children's current reading skills (Lyytinen et al. 2004; Snowling et al. 2003).

2. Methods

2.1 Participants

The sample included 91 (37 boys, 54 girls, 80 right-handed) mostly native (Swiss-)German-speaking children aged between 10 and 12 years in the 5th (n=90) or in the 6th (n=1) grade of elementary school. 17 children spoke another language next to (Swiss-)German. Most children were from middle- to upper-class income families (mean SES=62; Min.= 10, Max.= 89 according to ISEI-08, see below). Exclusion criteria were physical, neurological, or psychiatric disorders. Based on parents' report (questionnaire), our sample included children with delayed language development (n=13), diagnosis of developmental dyslexia (n=23) and attention deficit hyperactivity disorder (ADHD, n=9). The 9 children diagnosed with ADHD were either receiving no medication or we asked for medication to be discontinued before the behavioural tests. One child with an autism spectrum disorder was excluded. The Adult Reading History Questionnaire (ARHQ) of both parents served to identify children with a familial risk for dyslexia (Lefly & Pennington 2000). The ARHQ is a self-assessment questionnaire, in which a score of > 0.40 indicates a history of reading disability. Children in these families met criteria of heightened risk for dyslexia. Accordingly, a familial risk was presumed when at least one parent scored > 0.40 in the ARHQ (one parent n=39, both parents n=15, mothers n=26, fathers n=40) or if a sibling had reading problems (n=18). Hence children at risk and with poor reading skills are overrepresented in this study (see Table 1). Furthermore, 15 mothers and 35 fathers of our children performed below 1 SD in the standardised decoding fluency test, indicating current impairments in reading.

The participants were recruited by flyers, letters and advertisements distributed in schools in the context of a larger project on neural correlates of reading development and dyslexia. The research protocol was approved by the local ethics committee in Zurich, and all parents gave written informed consent in accordance with the Declaration of Helsinki.

	N	Minimum	Maximum	Mean	SD
Age	91	9.97	12.38	11.37	0.41
ARHQ mother	91	0.03	0.80	0.32	0.16
ARHQ father	89	0.06	0.79	0.40	0.15
ARHQ mean (both parents)	91	0.09	0.65	0.36	0.11
Vocabulary (PPVT4)[a*]	90	4.50	98.90	55.34	26.98
Reading fluency (SLRT-II W)[b*]	91	<1.00	95.00	37.19	31.32
Decoding fluency (SLRT-II PW)[b*]	91	<1.00	98.00	34.80	32.10
Text comprehension (ELFE II)[c*]	91	1.10	99.40	51.07	31.56
Non-verbal IQ (RIAS)[d]	91	80	123	104.65	6.96
SES	91	31	89	62.32	12.90
Reading fluency mother (SLRT-II W)[b*]	90	<1.00	93.50	41.99	26.20
Decoding fluency mother (SLRT-II PW)[b*]	90	<1.00	97.50	44.36	26.94
Reading fluency father (SLRT-II W)[b*]	83	<1.00	90.5	32.84	25.08
Decoding fluency father (SLRT-II PW)[b*]	83	<1.00	89.50	29.24	23.23

*Note: N = Number, SD = Standard deviation; ARHQ = Adult Reading History Questionnaire; SES = Socio-economic Status; PW = Pseudoword; W = Word; [a]Peabody picture vocabulary test (PPVT4); [b]Salzburger Lese- und Rechtschreibtest-II (SLRT-II); [c]Ein Leseverständnistest für Erst- bis Siebtklässler Version II (ELFE-II); [d]Reynolds Intellectual Assessment Scales and Screening (RIAS), *percentile scores; Mothers and fathers differed significantly with regard to their percentiles in reading fluency (t=3.66, p<0.001), decoding fluency (t=3.98, p<0.001) and their ARHQ risk scores (t=-3.35, p<0.001).*

Table 1: Mean, standard deviation (SD), minima, and maxima of the different reading, vocabulary, IQ, SES measures of the children, risk assessment and reading scores of their mothers and fathers.

The current study focussed on the analysis of reading skills, vocabulary, non-verbal IQ, and the questionnaires related to reading history and reading environment of the children.

2.2 Testing procedure and materials

Behavioural tests to assess children's reading and vocabulary skills, as well as other measurements (Table 1), took place at the children's home (n=61) or in an office at the Department of Child and Adolescent Psychiatry and Psychotherapy (n=30) and are detailed in the next section. In addition, the children's parents filled in several questionnaires and also conducted a timed overt word and pseudoword reading test (SLRT-II: Moll & Landerl 2014)[1]. Data on vocabulary skills was missing for one child, reading tests were missing for one mother and eight fathers and questionnaires were available for 90 families.

1 For a detailed test description see below.

2.2.1 Behavioural Tests

Reading fluency and decoding: Word and pseudoword reading fluency of the participating children and their parents was assessed using the one-minute-reading fluency tests of the "Salzburger Lese- und Rechtschreibtest" (SLRT-II) (Moll & Landerl 2014). The percentile rank (PR) of the number of correctly read words/pseudowords per minute served as a measure for reading fluency, respectively decoding fluency.

Reading comprehension: To measure reading comprehension, we administered the short version of the text comprehension subtest of ELFE-II ("Ein Leseverständnistest für Erst- bis Siebtklässler" Version II) by Lenhard et al. (2018). The children had six minutes to read as many short texts and subsequently select the correct answer out of four given options as possible. The number of correct answers was used to derive the PR of reading comprehension for each child.

Vocabulary: To estimate the receptive vocabulary of each child, the German version of the "Peabody Picture Vocabulary Test" Volume 4 (PPVT-4) by Lenhard et al. (2015) was conducted. The participant must choose out of four pictures the one that best matches to the word read aloud by the examiner. The PR was derived using the total number of correct answers.

IQ estimate: The non-verbal IQ of each child was estimated by use of the two non-verbal subtests "Odd Man Out" (German: Unpassendes ausschliessen) and "What's Missing?" (German: Was fehlt?) of the German edition of the "Reynolds Intellectual Assessment Scales and Screening" (RIAS) by Hagmann-von Arx & Grob (2014).

Further behavioural tests were carried out (not reported in the present study) and included examinations of verbal IQ (RIAS verbal part, Hagmann-von Arx & Grob 2014), rapid automatised naming of objects, colours, letters, numbers (subtests of the Test zur Erfassung der phonologischen Bewusstheit und der Benennungsgeschwindigkeit, Mayer 2013), rapid automatized naming of animals (Moll et al. 2005), math skills (Heidelberger Rechentest, Hafner et al. 2005), text reading accuracy (Zürcher Lesetest-II, Petermann & Daseking 2015), short term and working memory (Wechsler Intelligence Scale for Children-Fourth Edition, Wechsler 2011), reading speed (Salzburger Lese-Screening für die Schulstufen 2-9, Mayringer & Wimmer 2014), spelling (Deutscher Rechtschreibtest für 5. Klassen, Grund et al. 2015) and phonological awareness by phoneme blending and phoneme reversal tasks (Basiskompetenzen für Lese-Rechtschreibleistungen Stock et al. 2017).

2.2.2 Questionnaires

To get an estimate of children's preschool HLE and to have an index of parents' reading history, the parents filled in several questionnaires about their child's reading environment and interest in books as well as their own reading history.

The Adult Reading History Questionnaire (ARHQ) by Lefly & Pennington (2000) consists of 23 questions about the reading history and the current reading behaviour. It is a widely used measure to self-report the risk of reading disability (dyslexia) in adults. Both parents filled in this questionnaire to determine if there was a familial risk of dyslexia for the child (cf. Table 1). ARHQ values and parent's individual reading skills were highly correlated as expected (word reading fluency mother: $r = -.53$, $p < .001$; decoding mother: $r = -.61$, $p < .001$; word reading fluency father: $r = -.40$, $p < .001$; decoding father: $r = -.66$, $p < .001$). We chose pseudoword decoding fluency as the core measure to define parents' reading skills, because it was highly correlated with ARHQ values, and because this measure is more sensitive than word reading fluency to potential compensated reading problems.

Further questionnaires, which were developed within our group, enquired about children's reading interest, reading environment and childcare situation at home at preschool and kindergarten age (questions listed in Table 2), and about parents' occupation and education to obtain an estimate of the family's SES. The ISEI-08 score of the occupation as defined by the International Standard Classification of Occupations (Ganzeboom et al. 1992) was used to derive a SES estimate ranging between 10 and 89. In total, 14 questions (see Appendix Table A1) were entered to the subsequent principal component analysis (PCA, chapter 2.3).

2.3 Statistical analyses

For all statistical analyses, the IBM SPSS Statistics 25 software was used. First, a PCA with promax rotation was applied to the data to reduce the number of measures. The initially 14 measures resulting from the questionnaires were reduced to a small set of informative, independent summary factor scores. To justify the use of a PCA, the Kaiser–Meyer–Olkin measure of sampling adequacy (*KMO* = .61) and Bartlett's test of Sphericity ($p < .001$) were checked first. The four factors indicated in the scree-plot, all exceeding an Eigenvalue of 1 and accounting for 69% of the total variance, were considered for further analyses (cf. results).

For the reading measures of both parents, the SES and children's non-verbal IQ, Z-scores were computed and subsequently used for all analyses. Shapiro-Wilk tests showed that all variables were non-normally distributed, therefore Spearman's correlations were used to analyse the intercorrelations between all independent and dependent variables.

Finally, four multiple regression analyses were conducted to explain the variance in the four outcome measures vocabulary, reading fluency, decoding fluency and text comprehension in the 5th grade by eight independent variables. These variables included the four factor scores derived by the PCA and the Z-scores of the SES, the non-verbal IQ and the decoding fluency of father and

mother. For the multiple regression analyses, we first checked for outliers in the dependent and independent variables. Data with standardised residuals exceeding ±3 were excluded from further analyses (this applied to one case for the multiple regression with the dependent variable vocabulary). Afterwards, based on the guidelines by Huber (1981), three more subjects with a centred leverage value >0.2 in one of the independent variables were excluded for all the multiple regression analyses. Values of $p < .050$ were considered to be statistically significant and values of $p < .100$ as trends.

3. Results

3.1 Principal component analysis (PCA)

The factor loadings after rotation are summarised in Table 2. According to Stevens (2002), loadings greater than .51 were considered important, given the sample size of almost 100 children. The results from the pattern matrix indicated four components: component 1 represents the preschool childcare situation, component 2 the children's early interest in books, component 3 shared reading with the father & children's preschool reading skills and component 4 shared reading with the mother. 12 out of the 14 questions showed a significant loading on one of the four components (printed in bold type in Table 2).

3.2 Intercorrelation Analyses

The results of the Spearman's correlational analyses between all dependent and independent variables are illustrated and summarised in Appendix Figure A1.

	Rotated Factor Loadings			
Item	*Preschool childcare*	*Early interest in books*	*Shared reading father & preschool reading*	*Shared reading mother*
Preschool childcare 0-2 years old	**.93**	-.04	-.27	-.06
Preschool childcare 2-4 years old	**.96**	-.08	-.32	-.07
Preschool childcare 4-6 years old	**.93**	-.08	-.39	-.10
Was your child particularly interested in book(s) between the ages of 0 and 4?	-.09	**.80**	.34	.18
Was your child particularly interested in book(s) between the ages of 4 and 6?	.06	**.82**	.30	.05
Did your child have a favourite book that he/she wanted to read several times a week between the ages of 0 and 4?	-.23	**.60**	-.10	.45
Did your child have a favourite book that he/she wanted to read several times a week between the ages of 4 and 6?	-.14	**.71**	-.08	.48
How often did you (father) read together with your child between the ages of 0 and 4?	-.44	.14	**.91**	.09
How often did you (father) read together with your child between the ages of 4 and 6?	-.41	.13	**.91**	.08
Could your child already read simple texts at kindergarten age (4-6 years old)?	.03	.31	**.55**	.06
How often did you (mother) read together with your child between the ages of 0 and 4?	-.07	.28	.06	**.91**
How often did you (mother) read together with your child between the ages of 4 and 6?	-.06	.31	.11	**.90**
How often did your child talk during shared reading between the ages of 4 and 6?	-.28	.09	.26	.17
How often did your child ask questions during shared reading between the ages of 4 and 6?	-.27	.30	.22	.39
Eigenvalues	4.18	2.58	1.61	1.36
% of variance	29.83	18.41	11.52	9.73

Note: Factor loadings >.51 appear in bold.

Table 2: Summary of PCA results Note: Factor loadings >.51 appear in bold.

3.3 Predictors of the vocabulary

The multiple regression model explained 43% of the variance (adjusted R^2 = .43) in children's vocabulary skills in the 5th grade ($F(8,68) = 8.27$, $p < .001$, Table 3). From the eight independent variables, *non-verbal IQ* ($t = 3.14$, $p = .003$), *shared reading father & preschool reading* ($t = 2.76$, $p = .008$) and *shared reading mother (t = 2.02, p = .048)* showed a significant effect and *early interest*

in books showed a trend (t = 1.74, p = .087). The corresponding partial regression plots are shown in Appendix Figure A2.

	β	t	Sig.
Non-verbal IQ	**.32**	**3.14**	**.003**
SES	.05	0.47	.643
Decoding fluency mother	.11	1.12	.265
Decoding fluency father	-.09	-0.92	.363
Preschool childcare	.14	1.45	.152
Early interest in books	*.20*	*1.74*	*.087*
Shared reading father & preschool reading	**.30**	**2.76**	**.008**
Shared reading mother	**.21**	**2.02**	**.048**

Note: Significant effects appear in bold letters; trends appear in italic letters; β = standardised beta coefficient

Table 3: Summary of the multiple regression model for vocabulary

3.4 Predictors of reading fluency

34% of the variance (adjusted R^2 = .34) in children's reading fluency in 5th grade (F(8,70) = 5.98, p < .001, Table 4) was explained in the multiple regression model. *Decoding fluency father* (t = 2.65, p = .010) and children's *early interest in books* (t = 2.67 p = .009) showed a significant effect, *decoding fluency mother* (t = 1.99, p = .051) showed a trend. The corresponding partial regression plots are shown in Appendix Figure A3.

	β	t	Sig.
Non-verbal IQ	-.01	-0.11	.912
SES	-.01	-0.11	.912
Decoding fluency mother	*.22*	*1.99*	*.051*
Decoding fluency father	**.27**	**2.65**	**.010**
Preschool childcare	.07	0.71	.479
Early interest in books	**.33**	**2.67**	**.009**
Shared reading father & preschool reading	.17	1.52	.133
Shared reading mother	-.00	-0.01	.994

Note: Significant effects appear in bold letters; trends appear in italic letters; β = standardised beta coefficient

Table 4: Summary of the multiple regression model for reading fluency

3.5 Predictors of decoding fluency

39% of the variance (adjusted R^2 = .39) of children's decoding fluency in the 5th grade (F(8,70) = 7.21, p < .001, Table 5) was explained in the multiple regression model. The *mother's* (t = 2.28, p = .026) and the *father's* (t = 3.46, p = .001) *decoding fluency* showed a significant effect as well as children's *early interest in books* (t = 2.50, p = .015) and *shared reading father & preschool reading* (t = 2.24, p = .029). The corresponding partial regression plots are shown in Appendix Figure A4.

	β	t	Sig.
Non-verbal IQ	-.10	-0.92	.363
SES	-.11	-1.09	.279
Decoding fluency mother	**.24**	**2.28**	**.026**
Decoding fluency father	**.34**	**3.46**	**.001**
Preschool childcare	.08	0.85	.400
Early interest in books	**.30**	**2.50**	**.015**
Shared reading father & preschool reading	**.25**	**2.24**	**.029**
Shared reading mother	.01	0.12	.904

Note: Significant effects appear in bold letters; β = standardised beta coefficient

Table 5: Summary of the multiple regression model for decoding fluency

3.6 Predictors of reading comprehension

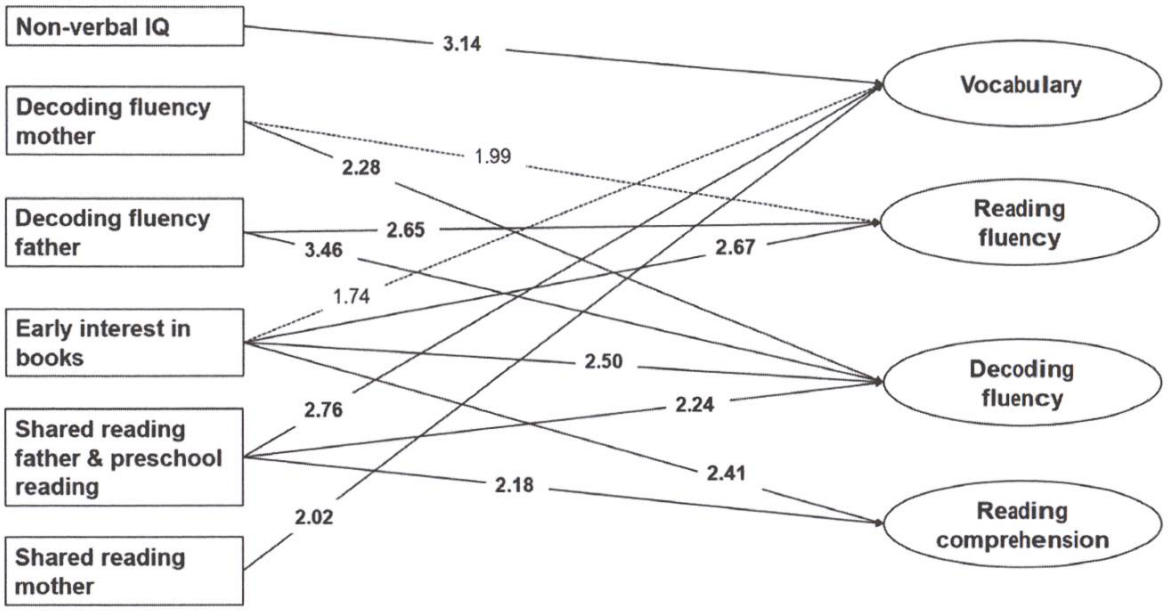
31% of the variance (adjusted R^2 = .31) of children's reading comprehension in the 5th grade ($F(8,70) = 5.39$, $p < .001$, Table 6) was explained in the multiple regression model. Only children's *early interest in books* ($t = 2.41$, $p = .019$) and *shared reading father & preschool reading* ($t = 2.18$, $p = .033$) significantly contributed to explaining the variance in reading comprehension. The corresponding partial regression plots are shown in Appendix Figure A5.

	β	t	Sig.
Non-verbal IQ	.17	1.52	.133
SES	-.07	-0.68	.500
Decoding fluency mother	.12	1.04	.301
Decoding fluency father	.13	1.22	.227
Preschool childcare	.08	0.73	.471
Early interest in books	**.30**	**2.41**	**.019**
Shared reading father & preschool reading	**.25**	**2.18**	**.033**
Shared reading mother	.02	0.14	.887

Note: Significant effects appear in bold letters; β = standardised beta coefficient

Table 6: Summary of the multiple regression model for reading comprehension

All the significant effects and trends of the four multiple linear regression models are summarised and presented in Figure 1. The figure nicely illustrates that preschool reading interest and home reading environment had significant positive effects on later reading, vocabulary and comprehension skills, while the reading skills of the parents exclusively relate to children's current reading skills.



Note: T-values are given on the arrows between variables. Solid arrows with bold numbers indicate a significant effect; dotted arrows indicate a trend. Only variables showing a significant (or trend) association are considered for this illustration.

Figure 1: Overall model, summarising the contributions of the different measures on the four outcome variables

4. Discussion

The goal of this study was to identify the influence of several preschool factors such as shared reading activities and children's interest in books as well as parents' current reading performance, the SES and the current non-verbal IQ on children's vocabulary, reading and decoding fluency and reading comprehension towards the end of elementary school. All regression analyses achieved a moderate to good prediction with explained variances ranging from 31% for text comprehension up to 43% for vocabulary size in 5th grade. Shared reading with parents at preschool age, children's preschool reading skills and children's early interest in books contributed to the prediction of most outcome variables. The non-verbal IQ of the children, in contrast, was exclusively relevant for explaining variance in vocabulary, and the parents current reading skills only contributed to explaining variance in children's fluency measures (word reading and decoding fluency). In the current sample, the estimated SES did not show any significant effect on reading skills or vocabulary. This is in accordance with previous evidence that the SES shows a greater influence on children's achievements and ability-related outcome in low-income than in high-income families (Duncan et al. 1998). Furthermore, the preschool childcare situation at children's homes did not account for any variance on reading and vocabulary skills.

4.1 Preschool HLE and early interest in books impact on children's later vocabulary and reading outcome

Our overall definition of preschool HLE included three factors, namely 'shared reading with the mother' and 'shared reading with the father and preschool reading skills', and 'children's early interest in books'. Shared reading with the parents was a significant predictor of vocabulary. It is, however, important to note that the factor of shared reading with the father also included children's preschool reading skills. Early interest in books was not significantly related to the development of children's vocabulary.

There is a large consensus that shared reading with parents at preschool age is beneficial for the development of vocabulary size in young children (Bracken & Fischel 2008; Bus et al. 1995; Sénéchal & Lefevre 2014) including children at risk for dyslexia (Caglar-Ryeng et al. 2020). Our findings of the strong impact of shared reading at preschool on later vocabulary outcome is therefore convergent with previous literature and confirms the beneficial effects of shared reading at home for building up a rich vocabulary. Moreover, our findings confirm that shared storybook reading is highly beneficial for children coming from middle to high SES backgrounds with a family background of dyslexia and children developing specific reading impairments. In contrast to the impact of shared storybook reading on vocabulary development, its impact on reading skills is less direct. According to the home literacy model (Sénéchal & LeFevre 2002, 2014), informal and meaning-related literacy activities such as storybook reading have only an indirect effect on reading through enhancing children's language skills (e.g. vocabulary). Direct effects on word reading may in contrast be expected through formal, print-related literacy activities such as letter teaching at preschool age (Sénéchal & Lefevre 2014). Our findings are in accordance with this model in that shared reading with the mother, an informal meaning-related activity, was not associated with reading. The effect of shared reading with the father and preschool reading on both decoding and reading comprehension in the 5th grade might be driven by the impact of preschool reading skills of the children on their further reading development, rather than shared reading with the father itself (Bowey 2005; Leppänen et al. 2008). In this study we did not specifically assess print-related teaching activities at children's homes. But it is likely that such activities fostered early preschool reading skills, which loaded on the factor shared reading with father. Such early preschool reading skills thus may explain the beneficial influence on children's long-term reading development. Of note, also shared reading may have indirect effects on reading comprehension in the long run: It has been shown, for example, that shared preschool storybook reading had a beneficial effect on reading comprehension in grade 4 (Sénéchal 2006).

While the effect of shared reading at preschool age most likely only indirectly influences future reading skills through early preschool literacy knowledge,

children's early interest in books was a strong predictor for all reading measures in the 5th grade. In this study, the factor '*early interest in books'* is formed by a questionnaire filled in by the parents. The questions that loaded on the factor asked on whether the child was particularly interested in books, and if the child had a favourite book at preschool and kindergarten age. Our results thus converge with the strong relationship between the attitude towards reading and reading achievement in primary school children as reported in a meta-analysis (Petscher 2010). Investigating reading self-concept, Katzir and colleagues (2009) obtained similar results for reading comprehension. In their study, children's attitude towards reading, as one of three dimensions considered for reading self-concept, showed a significant effect on reading comprehension in 4th-grade pupils (Katzir et al. 2009). In comparison to the strong effect on reading scores, the effect of reading interest on later vocabulary size in our sample was rather marginal. Moreover, the literature on the effect of early interest on vocabulary size or growth is inconsistent. Several studies show a beneficial effect of reading interest at preschool age on vocabulary growth (Bracken & Fischel 2008; Crain-Thoreson & Dale 1992) and others show no association (Caglar-Ryeng et al. 2020; Frijters et al. 2000; Sparks & Reese 2013).

While our results on the impact of HLE or early interest in books on vocabulary and reading outcomes largely coincide with previous literature, partly diverging results may be explained by a lack of standardised questionnaires or definitions on how to assess such factors. The assessment of "HLE" for example varies considerably among studies and includes different variables, such as shared storybook reading (Sénéchal 2006; Silinskas et al. 2020), parents' report of their own reading frequency and number of subscribed newspapers (Johnson et al. 2008; van Bergen et al. 2017), number of books at home (Katzir et al. 2009; Sénéchal et al. 1996), frequency of library visits (Caglar-Ryeng et al. 2020; Sénéchal & LeFevre 2002) among others. As with HLE, there are also different approaches to assess interest in books such as through a self-report by the children (Frijters et al. 2000) or questionnaires filled in by the parents (Bracken & Fischel 2008). Furthermore, different types of questions were used to assess reading interest, which again may explain diverging results. Moreover, reading and decoding fluency as well as vocabulary are often assessed at different times during reading development in primary school, which renders such comparisons difficult (Sénéchal et al. 1998; Silinskas et al. 2020).

4.2 Parental reading skills are strongly related to children's reading skills

In agreement with most previous studies (Lyytinen et al. 2004; Pennington & Lefly 2001; Snowling et al. 2003; van Bergen et al. 2012, 2015), our data provide evidence that children's reading and decoding fluency are strongly associated with the decoding fluency of their parents. This strong link between children's and parents' reading skills is likely to be mediated by genetic factors, as

indicated by a meta-analysis reporting a high heritability of 73% between reading scores of the parents and their children (de Zeeuw et al. 2015), and the finding that only the reading level of non-adopted, biological children, but not of adopted children is correlated with parental reading fluency (Wadsworth et al. 2002). Both parents contributed similarly to children's reading fluency skills in our study. In accordance with previous studies, our sample showed a higher prevalence of impaired reading in fathers than mothers (Hawke et al. 2009; Moll et al. 2014; Rutter et al. 2004). 47% of the fathers and 31% of the mothers exceeded the threshold for a high dyslexia risk as estimated by the adult reading history questionnaire (ARHQ) and 42% of the fathers and 17% of the mothers performed worse than 1SD below norms in the oral decoding fluency test. Despite the strong association between parents' and children's reading fluency skills, parents' decoding fluency did not show any significant effect on children's reading comprehension or vocabulary skills. Reading comprehension and vocabulary were better explained by literacy activities at children's homes as described in the former section.

4.3 Non-verbal IQ is associated with vocabulary in 5th grade

The non-verbal IQ showed a strong effect on children's vocabulary in the 5th grade, but it is not related to children's reading and decoding fluency nor to comprehension skills. Accordingly, children with better non-verbal abilities have on average a larger vocabulary. Even though both vocabulary and non-verbal IQ are often seen as stable and unrelated traits (Blaga et al. 2009), recent models emphasise the mutualistic coupling of basic cognitive abilities across development (Kievit et al. 2017). Apart from the study of Kievit and colleagues (2017), in which adolescents and adults were examined, studies in children with and without language impairments also indicate that a higher non-verbal IQ has a significant positive effect on receptive vocabulary growth (Lervåg et al. 2019; Rice & Hoffman 2015). The strong relation of non-verbal IQ and vocabulary findings in our study are thus in accord with such a mutualist model account (Kievit et al. 2017).

In contrast to vocabulary, we found no indication that non-verbal abilities of children are associated with their reading skills in 5th grade. This partly agrees with the results of Ribeiro and colleagues (2016). In their study, no significant relation between non-verbal reasoning and reading comprehension in 2nd grade school children were found after controlling for demographic variables and several reading related factors. For reading comprehension in 4th grade, however, they found a significant correlation. Similarly, in a study of Tighe and Schatschneider (2014), non-verbal IQ only explained 1% of the variance of reading comprehension in 3rd-grade students. Later, in the 10th grade, reasoning was the best predictor of reading comprehension, which may indicate that reasoning becomes more important for reading comprehension in later grades. The reasoning factor in their study, however, also included verbal IQ and thus

cannot be directly compared with our results. Finally, we need to consider that the dynamic interrelation between IQ (full scale) and reading skills may also differ between children with and without dyslexia, as shown by Ferrer and colleagues (2009). In their study, IQ was associated with reading skills in children with typical development, but the influence of IQ was minor for children with dyslexia (Ferrer et al. 2009). A direct comparison to our results is, however, difficult because we used non-verbal and not the full IQ measure and studied a sample including both children with and without dyslexia.

4.4 Limitations

This study contributes to the existing knowledge about early predictors of vocabulary, reading fluency, decoding fluency and reading comprehension by means of preschool HLE, preschoolers' reading interests as well as parental reading skills. Although our results largely correspond to previous studies, there are some limitations to be mentioned. First, our rather restricted sample included mostly families with a middle- to upper-class socio-economic background. Secondly, children with poor reading skills together with children at familial risk for reading impairments are strongly overrepresented in our sample, but the sample is still too small to study differences in subgroups of impaired or non-impaired, at-risk or no-risk children. The current data have been collected in the context of a larger ongoing neuroimaging study on reading acquisition and reading impairments (Karipidis et al. 2018; Mehringer et al. 2020; Pleisch et al. 2019). Thus, the relatively restricted sample, the over-representation of families with a high educational background and a high SES, and the increased number of children with familial risk for dyslexia and poor reading skills can be explained by the study design. It is important to note that the results of the multiple regression coefficients are conditional on the other predictors in the model and do not allow any causative inferences (Vanhove 2021). Therefore, the results of the multiple regression analyses are not directly transferrable to children of low SES families or with low familial risk for reading impairments.

An additional problem in the field is the absence of standardised and comparable questionnaires to assess HLE and children's reading interests. While we had several questions from which to derive HLE, we did not ask for library visits or number of books at home. Such measures are, however, often part of HLE questionnaires (Caglar-Ryeng et al. 2020; Sénéchal & LeFevre 2002). Further, for HLE we only collected informal, meaning-related literacy activities but not formal parental print-related teaching activities, which would have allowed more detailed examination of differential effects of such HLE factors on literacy and vocabulary outcomes (Sénéchal & Lefevre 2014). Finally, as usual with retrospective assessments, it is difficult to judge on how well the parents remembered the HLE situation that took place 5 or 10 years ago.

4.5 Conclusion

In line with previous literature, our study showed that shared storybook reading with both parents at preschool is an important predictor of the long-term development of children's vocabulary skills but has only a weak relation to the development of reading skills. This clearly indicates that despite the differences in how HLE is assessed across studies, shared reading at preschool age is an important factor in a child's environment to develop a rich vocabulary which in turn may support reading comprehension in advanced stages of reading development. Finally, children's reading outcomes are strongly related to parental reading, confirming the strong genetic transmission of these skills and are, furthermore, associated with children's early interest in books and preschool reading skills.

The results of our sample of German-speaking children, with reading skills ranging from severely impaired to excellent, coming from moderate to high SES families and most of them carrying a risk for developmental dyslexia, thus emphasise again previous accounts of the important influence of preschool HLE and reading interests on children's subsequent development of vocabulary and reading skills.

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* These references are available online.

Appendix

Figure A1

Significant correlations (surviving correction for multiple comparisons) were found between children's vocabulary and reading comprehension, children's vocabulary and non-verbal IQ, children's vocabulary and *shared reading father & preschool reading*, reading fluency and decoding fluency, reading fluency and reading comprehension, decoding fluency and decoding fluency of the mother and of the father, reading fluency and *early interest in book*, decoding fluency and reading comprehension, decoding fluency and decoding fluency of the father, decoding fluency and *early interest in books*, decoding fluency and *shared reading father & preschool reading*, reading comprehension and non-verbal IQ, reading comprehension and *early interest in books*, reading comprehension and *shared reading father & preschool reading*, SES and non-verbal IQ, non-verbal IQ and *shared reading father & preschool reading* and between mothers decoding fluency and *early interest in books*. The scatter plots were produced in R (R Core Team 2020) with the package psych, function pairs.panels (Revelle & Revelle 2015).

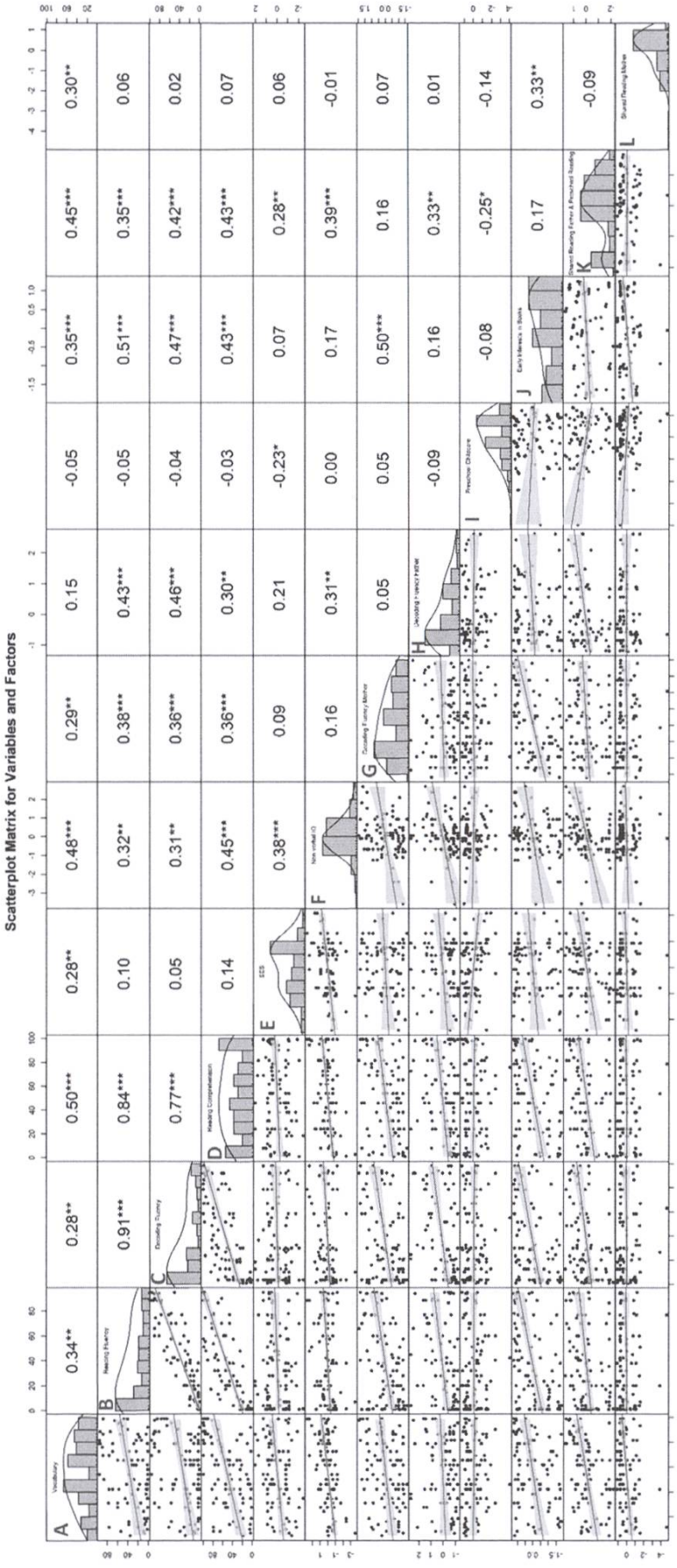

Figure A1: On the diagonal, a histogram of each variable shows the data distribution. Scatter plots of the relationship between each pair of variables can be found below the diagonal with x-axis scaled to the column variable and y-axis to the row variable. Spearmans's Rho values and their statistical significances are given in the corresponding boxes on the right hand side; *p<0.05, **p<0.01, ***p<0.001.Labelling (blue letters) of variables is as follows: A: vocabulary; B: reading fluency ; C: decoding fluency; D: reading comprehension; E: SES; F: non-verbal IQ; G: decoding fluency mother; H: decoding fluency father; I: preschool childcare; J: early interest in books; K: shared reading father & preschool reading; L: shared reading mother

Figure A2

Vocabulary: Partial regression plots of the factors predicting vocabulary in 5th grade school children.

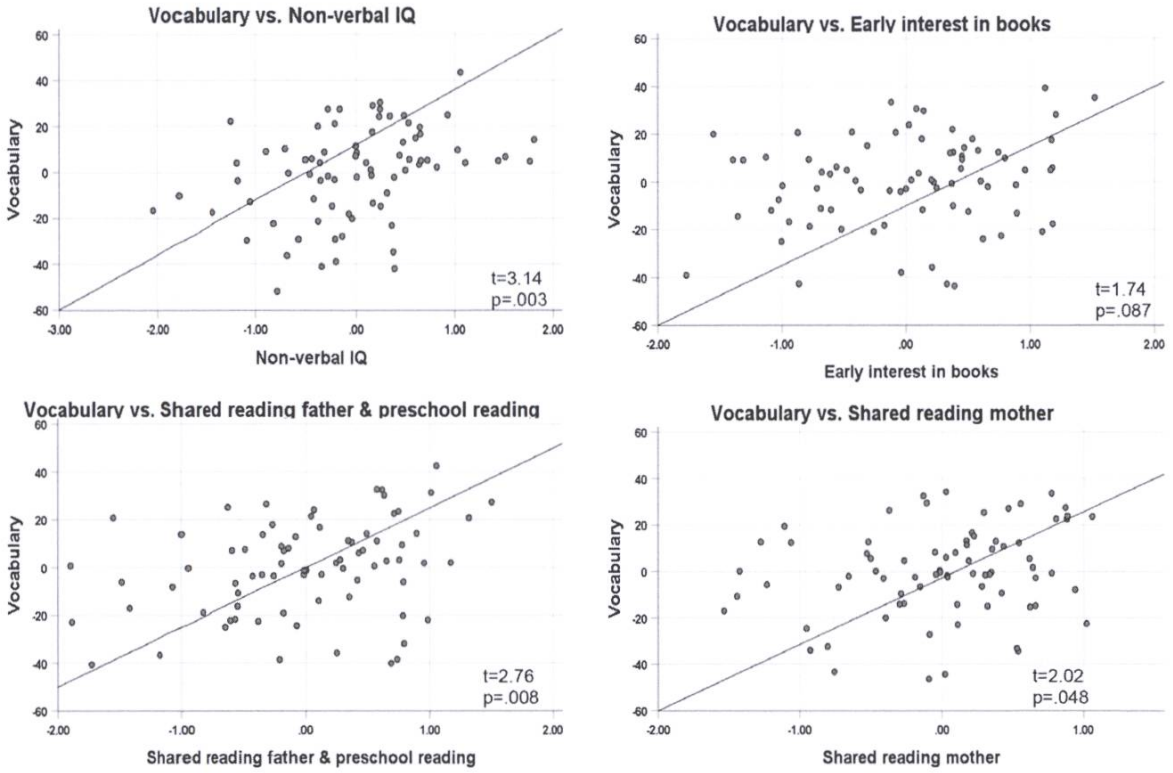

Figure A2: Partial regression plots of the multiple regression model to explain vocabulary

Figure A3

Reading fluency: Partial regression plots of the factors predicting reading fluency in 5th grade school children.

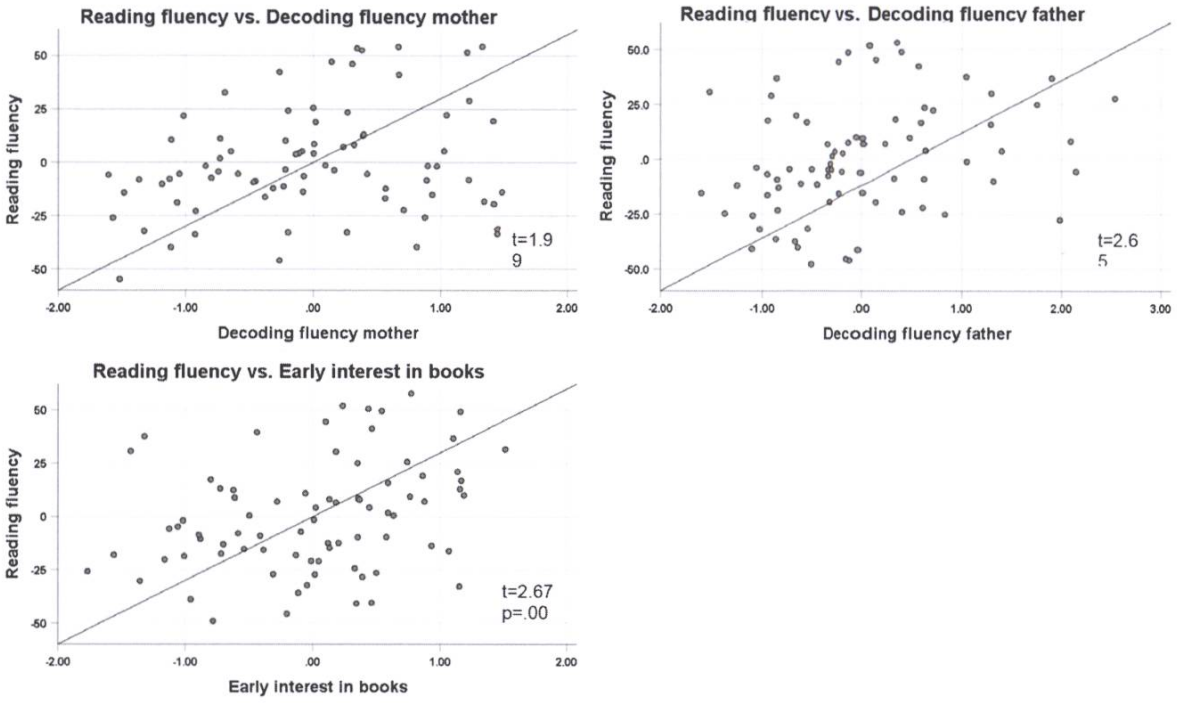

Figure A3: Partial regression plots of the multiple regression model to explain reading fluency

Figure A4

Decoding fluency: Partial regression plots of the factors predicting decoding fluency in 5th grade school children.

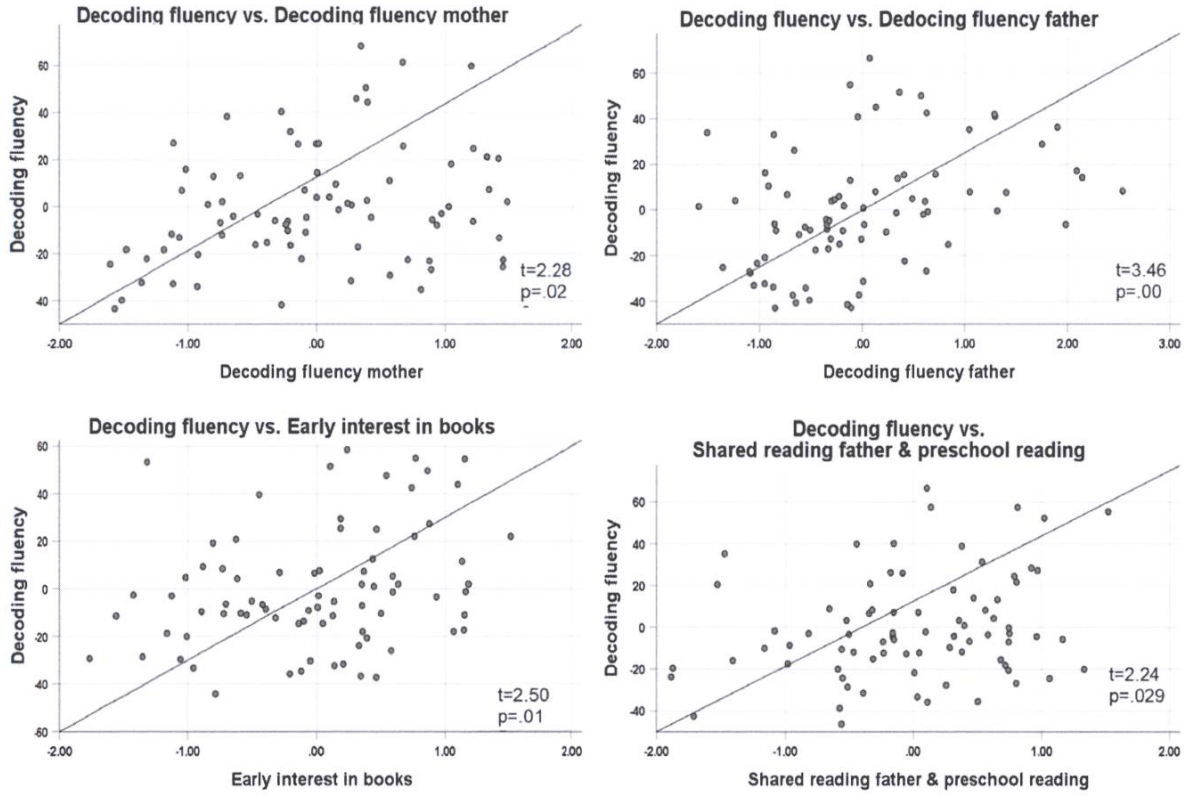

Figure A4: Partial regression plots of the multiple regression model to explain decoding fluency

Figure A5

Comprehension: Partial regression plots of the factors predicting reading comprehension in 5th grade school children.

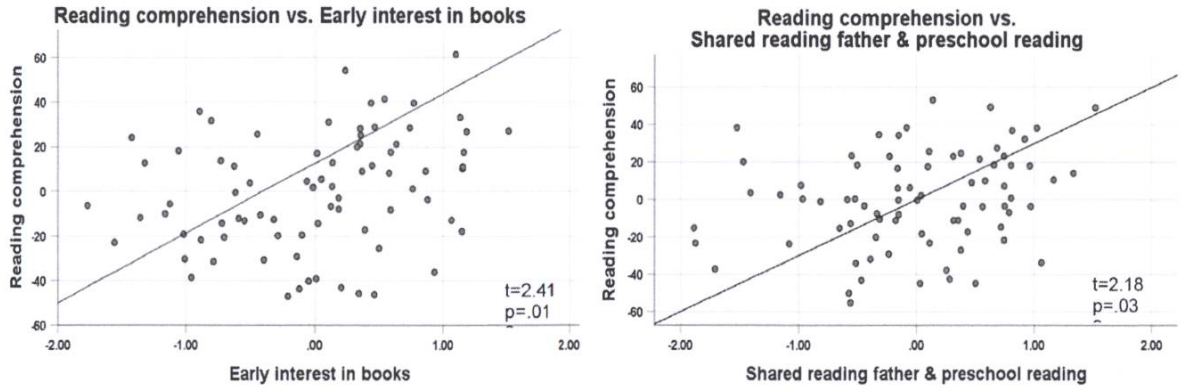

Figure A5 Partial regression plots of the multiple regression model to predict reading comprehension

Table A1

Compilation of questions from the two questionnaires used in this study.

Vorschulalter (0-4) Jahre					
Hat sich Ihr Kind speziell für (Bilder-) Bücher interessiert?				o Ja o Nein	
Hatte Ihr Kind ein Lieblingsbuch? (ein Buch/mehrere Bücher, welche das Kind jeden Tag/mehrmals in der Woche lesen möchte?)				o Ja o Nein	
Kindergarten (4-6 Jahre)					
Hat sich Ihr Kind speziell für Bücher interessiert?				o Ja o Nein	
Hatte Ihr Kind ein Lieblingsbuch? (ein Buch/mehrere Bücher, welche das Kind jeden Tag/mehrmals in der Woche lesen möchte?)				o Ja o Nein	
Vorschulalter (0-4) Jahre					
Wie oft haben Sie (Mutter) mit Ihrem Kind gemeinsam Bücher angeschaut/vorgelesen/erzählt?				o Selten o Monatlich o Wöchentlich o Täglich	
Kindergarten (4-6 Jahre)					
Wie oft haben Sie (Mutter) mit Ihrem Kind gemeinsam Bücher angeschaut/vorgelesen/erzählt?				o Selten o Monatlich o Wöchentlich o Täglich	
Vorschulalter (0-4) Jahre					
Wie oft haben Sie (Vater) mit Ihrem Kind gemeinsam Bücher angeschaut/vorgelesen/erzählt?				o Selten o Monatlich o Wöchentlich o Täglich	
Kindergarten (4-6 Jahre)					
Wie oft haben Sie (Vater) mit Ihrem Kind gemeinsam Bücher angeschaut/vorgelesen/erzählt?				o Selten o Monatlich o Wöchentlich o Täglich	
Konnte Ihr Kind im Kindergarten schon selber einfache Texte lesen?				o Ja o Nein	
Wie oft stellte Ihr Kind Fragen beim gemeinsamen Lesen?				o Nie/kaum o Eher selten o Manchmal o Häufig o (fast) immer	
Wie oft redet Ihr Kind während dem gemeinsamen Vorlesen/Bücher anschauen?				o Nie/kaum o Eher selten o Manchmal o Häufig o (fast) nie	
Ausbildung der Eltern					
Beruf Mutter (Bei Hausfrau/-mann: Zuletzt ausgeübte Erwerbstätigkeit)					
Beruf Vater (Bei Hausfrau/-mann: Zuletzt ausgeübte Erwerbstätigkeit)					
Zeitliche Aufteilung der Kinderbetreuung (ausserhalb der Fremdbetreuungszeiten)					
Alter Kind zwischen 0-2 Jahre					
Mutter	95-100%	75%	50%	25%	0-5%
Vater	95-100%	75%	50%	25%	0-5%
Alter Kind zwischen 2-4 Jahre					
Mutter	95-100%	75%	50%	25%	0-5%
Vater	95-100%	75%	50%	25%	0-5%
Alter Kind zwischen 4-6 Jahre (Kindergarten)					
Mutter	95-100%	75%	50%	25%	0-5%
Vater	95-100%	75%	50%	25%	0-5%

Table A1: Overview of the questions used in this study in the two questionnaires