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Preschool predictors of learning to read and spell in an additional language: a two-wave longitudinal study in a multilingual context

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Abstract

The study explores whether foundational skills of reading and spelling in preschool (age 5–6) predict literacy skills cross-linguistically in an additional language in Grade 1 (age 6–7). A sample of linguistically diverse preschool children completed tasks of phonological awareness, letter-sound knowledge, verbal-short term memory, rapid automatized naming, and lexical knowledge in the language of preschool instruction Luxembourgish. The children were followed-up in Grade 1 where literacy skills were assessed in the language of schooling, i.e., German, after five months of literacy instruction. German was a non-native language for all children. Longitudinal correlations confirm that individual differences in single word/pseudoword reading and spelling in German in Grade 1 can be predicted by all the foundational literacy skills that were assessed in Luxembourgish. Path analyses showed that phonological awareness in Luxembourgish emerged as the strongest unique predictor of Grade 1 literacy skills in German. The second unique preschool predictor of Grade 1 literacy skills was letter-sound knowledge. Results are consistent with the view that literacy development in an additional language builds upon similar building blocks as literacy acquisition in a first language, at least for languages that are typologically close. However, current findings suggest that respective contributions between predictors and literacy skills in children learning to read in an additional language may vary from patterns observed in studies with children acquiring literacy in their first language.

Keywords Additional language · Cognitive predictors · Early literacy development · Longitudinal · Preschool

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Introduction

Extensive research has explored the importance of proximal skills underlying literacy acquisition in monolingual settings (Caravolas et al., 2012, 2019; Georgiou et al., 2012; Landerl et al., 2019; Melby-Lervåg et al., 2012; Muter et al., 2004). With the continuous increase in linguistic diversity in schools worldwide, a growing body of research on literacy acquisition in an additional language has emerged (August and Shanahan, 2010; Grosjean, 2010; Murphy and Unthiah, 2015). Most studies exploring emergent literacy skills in second language learners have, however, been conducted in contexts in which the language of literacy instruction is also the majority language of the country, e.g., Spanish-speaking language-minority children learning to read in English in the United States (Lonigan et al., 2013), or Turkish-speaking language-minority children learning to read in German in Germany (Limbird et al., 2014). Here we aim to extend the scope of research on second language acquisition by exploring literacy development in a context in which the language of reading instruction is not the main language spoken in the country. The study took place in Luxembourg, where preschool instruction is in Luxembourgish and literacy instruction starts in German in Grade 1. Luxembourgish and French are the main languages used for spoken communication in Luxembourg and German is an additional language for 98% of the children in Luxembourg's public schools (Gilles, 2020; MENFP, 2017). The study followed children from preschool to Grade 1 and explores cross-linguistic preschool predictors of literacy skills a year later. The term additional language is used here to refer to children who acquire literacy in another language than their first language(s), also often referred to as second language (L2) learners of that language.

Foundational skills of reading and spelling

The importance of foundational skills of reading and spelling such as phonological awareness, rapid automatized naming (RAN), verbal short-term memory, letter-sound knowledge (LSK) and oral language for literacy acquisition has been shown across languages with varying degrees of orthographic consistency (Caravolas et al., 2012; Landerl et al., 2019; Melby-Lervåg et al., 2012; Ziegler et al., 2010). Phonological awareness is important for learning to read for multiple reasons, but primarily because it allows the development of a secure linkage between phonological representations of spoken language and orthographic representations of written language (for review see Melby-Lervåg et al., 2012). In alphabetic scripts letters represent the phonemes of the spoken language (Foulin, 2005) and LSK enables children to decode written words into speech (reading) or encode speech into written words (spelling). The ultimate purpose of reading is reading comprehension and to extract meaning from written text, oral language skills are required (Melby-Lervåg and Lervåg, 2014). The exact

relationship between RAN and literacy acquisition is less clear and much debated (for review see Kirby et al., 2010; Lervåg and Hulme, 2009; Norton and Wolf, 2011). However, perspectives on the RAN-reading association converge in RAN tapping speed of access to familiar phonological information, which seems critical for word recognition, reading fluency and orthographic spelling (Kirby et al., 2010). Verbal short-term memory plays an important role in literacy development because reading and spelling tasks involve simultaneous information processing and storage (Peng et al., 2018). There are different theoretical positions on the specific association between verbal short-term memory and literacy acquisition (see Arrington et al., 2014; Gathercole and Baddeley, 1993; Melby-Lervåg et al., 2012). According to a widely acknowledged account, verbal short-term memory plays an important moderating role during the early phase of literacy acquisition by restricting the amount of phonological and graphemic information that can be activated at a given time, especially during the decoding phase when grapheme to phoneme correspondences are not automatized yet (Baddeley, 1986).

Early predictors of reading and spelling in monolingual contexts

Although studies in monolingual settings have consistently shown that phonological awareness, LSK, oral language, RAN and verbal short-term memory are reliable predictors of literacy development (Caravolas et al., 2012; De Jong, 2011; Dessemontet and De Chambrier, 2015; Landerl et al., 2019; Moll et al., 2014; Torppa et al., 2013), controversies on the relative importance of these skills across literacy components and orthographies remain. Phonological awareness has emerged as a strong predictor of reading and spelling in inconsistent orthographies such as English or French (Muter et al., 2004; Ziegler et al., 2010). However, studies in more consistent orthographies have assigned a limited predictive role of phonological awareness for reading (Aarnoutse et al., 2005; Georgiou et al., 2012; Landerl et al., 2019; Papadopoulos et al., 2009; Silvén et al., 2007). German is considered a more consistent orthography in terms of grapheme to phoneme correspondences involved in reading, which in turn is thought to facilitate the transition from alphabetic to orthographic reading in German (Bergmann and Wimmer, 2008; Seymour et al., 2003). Although evidence of the importance of phonological awareness in literacy development in German exists (Pfost, 2015; Wimmer et al., 2000), some studies in German have failed to identify phonological awareness as a unique predictor of early word reading (Fricke et al., 2016; Landerl et al., 2019). Phonological awareness showed weaker correlations with early reading than with early spelling in German, which has been explained by greater orthographic consistency for reading (grapheme to phoneme correspondences) than for spelling (phoneme to grapheme correspondences) of the German orthography (Fricke et al., 2016; Pfost, 2015). Studies in German have also shown that RAN accounted for more individual differences in reading skills than phonological awareness in German (Fricke et al., 2016; Landerl et al., 2019). The authors argue that the early acquisition of high word reading accuracy combined with the use of reading speed measures to assess reading skills explains, at least partly, why RAN was a stronger predictor of literacy acquisition in German than

phonological awareness. LSK has been consistently identified to account for unique variance in many literacy components (reading accuracy, reading fluency, reading comprehension and spelling) in multiple orthographies with varying degrees of consistency (Anthony et al., 2003; Bowey, 2005; Hammill, 2004; Huang et al., 2014; Lerner and Lonigan, 2016; Piasta and Wagner, 2010; Puranik et al., 2011) and in German (Fricke et al., 2016; Landerl and Wimmer, 2008). Phillips and Torgesen (2006) postulated that the systematic matching of letters in print to phonemes in spoken words is the single most reliable clue for the ability to identify words at their first encounter. Oral language skills have been shown to mainly account for individual differences in reading comprehension (Duff et al., 2015; Fricke et al., 2016; Harlaar et al., 2007; Lervåg et al., 2018; Van Viersen et al., 2018). However, oral language has also been linked to decoding skills through their influence on the development of phonological awareness and LSK (Carroll et al., 2003; Hipfner-Boucher et al., 2014; Kendeou et al., 2009). In the early phase of literacy development, reading comprehension is substantially moderated by decoding skills and linguistic comprehension gradually becomes more important for reading comprehension with the mastering and automatizing of decoding (Caravolas et al., 2019; Lervåg and Aukrust, 2010). Significant relationships between verbal short-term memory and literacy skills emerged across a range of studies (Engel de Abreu and Gathercole, 2012; Peng et al., 2018, Steinbrick and Klatte, 2008; Yeong and Rickard Liow, 2011). However, many phonological awareness tasks (such as segmenting sounds in spoken works) also require efficient operation of phonological codes in memory (Gathercole and Baddeley, 1993). An on-going debate revolves around whether there is a direct causal connection between variations in verbal short-term memory that is separable from phonological memory skills required to solve phonological awareness tasks, or whether contributions of verbal-short term memory to literacy acquisition are better explained in terms of shared variance with phonological awareness skills (for review see Melby-Lervåg et al., 2012).

Early predictors of reading and spelling in an additional language

The relationship between early predictors of literacy in settings with linguistically diverse children has been studied from two major perspectives. Firstly, studies explored to what extent foundational literacy skills in the language of literacy instruction can predict later literacy skills for children speaking the language of literacy instruction as an additional language. Findings suggest that literacy acquisition in an additional language seems to build upon the same key building blocks as becoming literate in the first language (Chiappe et al., 2002; Jongejan et al., 2007; Swanson et al., 2011). There is, however, tentative evidence suggesting that lower lexical knowledge in the language of literacy instruction observed in children acquiring literacy in an additional language may lead to a greater and longer reliance on code-related skills (such as phonological awareness and LSK) to read words compared to children acquiring literacy in their first language (Geva and Yaghoub Zadeh, 2006; Jongejan et al., 2007). Chiappe et al. (2002), for example, found that LSK in English explained more variance in decoding skills for English

as an additional language learners (25%) compared to their monolingual peers (12%). Similarly, Jongejan et al. (2007) found that phonological awareness in Dutch remained the strongest predictor of spelling in Grades 3 and 4 for children learning Dutch as an additional language but not for their peers who spoke Dutch as a first language. Nevertheless, in comparison to children acquiring literacy in their first language, children learning to read in an additional language seem to exhibit comparable performance on reading measures tapping the decoding aspect of reading skills in the early school years (Kieffer and Vukovic, 2013; Lesaux et al., 2008; for a recent review see Murphy, 2018). For an example in Germany, Limbird et al. (2014) found no differences in means and growth pattern of phonological awareness and decoding skills in Grade 1 and Grade 2 between a group of Turkish-bilingual children and a German monolingual group matched for SES, cognitive abilities, family, and educational background variables. Traditionally, differences between children acquiring literacy in their first or in an additional language have mainly observed in measures tapping a reading comprehension component (Murphy, 2018). Studies have clearly shown that children learning to read in an additional language can struggle with measures of reading comprehension in comparisons to monolingual peers and these differences have been directly linked to lower lexical knowledge in the language of literacy instruction (Bialystok et al., 2010; Hoff et al., 2012; Jean and Geva, 2009; Melby-Lervåg and Lervåg, 2014; Raudszus et al., 2018).

The second major perspective of research on literacy acquisition in linguistically diverse children has focused on cross-linguistic associations between foundational skills of reading and spelling in one language and literacy skills in another language (Gebauer et al., 2013; Haigh et al., 2011; Swanson et al., 2015). Two major theoretical lines are generally studied in cross-language relationships: the contrastive analysis hypothesis (Lado, 1964) and the interdependence hypothesis (Cummins, 1978, 1979).

According to the interdependence hypothesis the acquisition of a first and an additional language are interdependent and transfer between languages occurs because languages rely upon a common underlying language proficiency (CULP; for details, see Genesee et al., 2008). However, it is currently unclear what the common underlying proficiency actually represents and how exactly additional language learning is supported by it (Genesee, 2006; Melby-Lervåg and Lervåg, 2011). The contrastive analysis hypothesis offers a more specified account by suggesting that cross-linguistic relationships are contingent on typological similarity between the languages. Structural domains (such as phonology or lexical knowledge) are more likely to transfer from one language to another when languages share features (such as cognate vocabulary or phonological forms) than when they are typologically less similar (Odlin, 1989). Cross-linguistic relationships seem also stronger for less language specific domains (such as phonological processing skills) than for more language specific domains (such as lexical knowledge), and stronger within language domains than across language domains such as phonology to lexical knowledge (Genesee et al., 2008; Goodrich and Lonigan, 2017). For example, Erdos et al. (2011) showed that for English-speaking students in an early total French immersion program in Canada, preschool (age 4–6) LSK and phonological awareness in English, but not RAN

objects in English, assessed in preschool were unique predictors of French decoding in Grade 1. In the same study, phonological awareness, LSK and RAN objects in English were predictors of reading comprehension in French in Grade 1. In a study from Luxembourg, Engel de Abreu and Gathercole (2012) showed that phonological awareness skills in Luxembourgish were specifically linked to word reading and spelling in children´s additional language German, but not to reading comprehension in German after controlling for Luxembourgish vocabulary in Grade 2 (age 8). However, only a very limited number of studies have investigated this line of crosslinguistic research in the context of literacy acquisition in multilingual settings.

Context of the study

Luxembourg has three official languages(i.e., Luxembourgish, French and German) and Luxembourg's educational system is multilingual. Preschool education in Luxembourg consists of two compulsory years (age 4–6) and the language of instruction is Luxembourgish. Luxembourgish has traditionally been used as a predominantly spoken language in Luxembourg but its use as a written language is increasing (Gilles, 2020). In the school year 2015–16, around 40% of primary school children grow up speaking primarily Luxembourgish at home and the percentage is decreasing in the earlier school years. Based on census data on the general school population in Luxembourg, approximately 22% of the children speak Portuguese at home, 15% French and 5% Serbo-Croatian. German is the main home language for only 2% of the Luxembourgish school population (Lenz and Heinz, 2018; MENFP, 2017). Preschool teaching is based on a holistic play-based teaching approach. The preschool curriculum involves fostering Luxembourgish oral language skills and immersing children in stimulating settings that promote print awareness and the foundational skills of reading and spelling (e.g., identify rhymes and initial sounds; raise print and book awareness; discover their first name among other names) in play-based learning activities. Preschool teaching does not incorporate formal literacy or letter-sound correspondences instruction (MENFP, 2011).

In Luxembourg, literacy instruction starts in Grade 1 (age 6–7) and is not taught in Luxembourgish but in German. German is typologically close to Luxembourgish and letter-sound correspondences in Luxembourgish and German are highly similar (Gilles and Trouvain, 2013). Luxembourgish represents the language spoken in parliamentary debates and is increasingly used for official public announcements, which used to be mainly in French (Gilles, 2020). At the workplace, French is the most used language in the private sector and also as a lingua franca in shops or restaurants. Besides its major role as language of instruction in primary school, German is used as a passive language of print media (newspapers, German TV programs) and represents, together with Luxembourgish and French, one of the three languages of public administration in Luxembourg (Gilles, 2020).

Research aims and hypotheses

This study explored the cross-linguistic relationship between foundational skills of reading and spelling in preschool and literacy skills in German in Grade 1 in children growing up in Luxembourg. All children spoke German as an additional language. Children were assessed on phonological awareness, LSK, verbal short-term memory, RAN and lexical knowledge in Luxembourgish at the end of Year 2 in preschool (age 5–6). A second assessment wave was administered nine months later, after five months of literacy instruction in Grade 1 in German and assessed single word/pseudoword reading and spelling in German. In line with the interdependence hypothesis (i.e., transfer between languages occurs because languages rely upon a common underlying language proficiency) but mainly based on the contrastive analysis hypothesis (i.e., cross-linguistic transfer is moderated by typological similarity) we expected cross-linguistic relationships as Luxembourgish and German are typologically very close. Based on previous studies from Germany (Fricke et al., 2016; Landerl et al., 2019; Wimmer et al., 2000), we expected phonological awareness, RAN, verbal short-term memory and LSK in preschool to show relationships with literacy skills in German in Grade 1. More specifically, we anticipated that LSK and RAN in Luxembourgish would uniquely predict single word/pseudoword reading and spelling skills in German, and that phonological awareness would reveal limited predictive power of single word/pseudoword reading skills due to the high consistency of grapheme to phoneme correspondences (utilized for reading) of the German orthography. However, as the German orthography exhibits a higher degree of inconsistency in the spelling direction, we expected preschool LSK, RAN and phonological awareness to be predictive of spelling in Grade 1. We expected no unique predictive role of lexical knowledge in Luxembourgish on German literacy skills, due to the early phase of literacy acquisition and the language specific nature of vocabulary. Based on a meta-review by Melby-Lervåg et al. (2012), we also hypothesized that verbal short-term memory would be related to literacy skills in Grade 1, but that it would not account for unique variance in literacy skills.

Method

Children were followed longitudinally and assessed on foundational skills of reading and spelling and literacy skills as the control group of a larger intervention study (Engel de Abreu et al., 2020). Ethical approval for the study was granted by the Ethics Review Panel of the University of Luxembourg (16–014 LITMUL CV/vg) and was notified to the Luxembourg National Commission for Data Protection (CNPD). The Luxembourg Ministry of Education, respective school directors and teachers gave consent for the study. Informed consent was obtained from parents/caregivers for their child to be involved.

Participants

One hundred children from four public preschools (14 classrooms) were followed longitudinally and assessed on foundational skills of reading and spelling in Luxembourgish at the end of the second year of preschool and on literacy skills in German in Grade 1. Two children ($n=2$) were excluded from the study as they spoke German as their main home language. Nine children could not be followed-up from preschool to Grade 1 due to moving school ($n=7$) or year retention ($n=2$). No child had a significant health problem or was seeing a professional with regard to language or speech difficulties as indicated by caregiver reports. All children had attended the first year of preschool in Luxembourg. The final sample consisted of 89 children ($n=50$ male), aged 5;9–7;4 ($M_{age}=6;2$) in preschool and 6;4–7;11 ($M_{age}=6;10$) in Grade 1. Background information on socio-economic status (SES) and home language were gathered via caregiver questionnaires. Participants came from a range of socio-economic backgrounds. The average International Socio-Economic Index score (HISEI = highest ISEI of either caregiver or only available caregiver; Ganzeboom and Treiman, 1996) was 55.89 ($SD=21.98$), which is representative of the SES for the Luxembourg school population (HISEI = 55.99, authors' calculation based on OECD Programme for International Student Assessment (PISA) 2018, weighted by individual weights), and ranged from 14 (e.g., agricultural farmers, cleaners) to 89 (e.g., medical doctors, managers). For 31 out of 89 (35%) children, Luxembourgish was not the dominant home language. German was an additional language for all children. The major non-Luxembourgish home languages were Portuguese (48%), followed by French (26%) and Polish (6%). All children were instructed according to the national curriculum for preschools and had followed almost two years of compulsory education in Luxembourgish by the time of the assessment in preschool. In Grade 1, all children followed the national curriculum for Grade 1 (MENFP, 2011).

Materials and procedure

Children were administered a comprehensive test battery tapping foundational literacy skills in Luxembourgish in preschool and literacy measures in German in Grade 1. Each child was tested individually in a quiet area outside the classroom in two testing sessions of around 25 min each. As no standardized tests of foundational literacy skills in Luxembourgish exist, all the measures were newly developed or adapted from existing German or English tests. In Grade 1, standardized German literacy tests were administered. As no norms exist for children in Luxembourg on these measures, raw scores were used in all analyses.

Preschool measures (predictors) in Luxembourgish

Phonological awareness. Children completed an adapted Luxembourgish version of the German '*Test für Phonologische Bewusstheitsfähigkeiten'* [Test for phonological awareness skills] (TPB; Fricke and Schaefer, 2011). The assessment contains three training items and 12 test items per subtest. The following subtests were administered: (1) *syllable segmentation* (segment spoken words into constituent syllables); (2) *rhyme identification* (identify the word that rhymes with a target among a choice of three); (3) *onset-rime blending* (pronounce a word by blending onset and rime); (4) *onset identification* (identify the word that has the same onset as a target among a choice of three); (5) *onset/ phoneme manipulation* (say a non-word by deleting the initial onset of a real word); (6) *phoneme blending* (pronounce a word by blending phonemes); (7) *phoneme segmentation* (segment words into constituent phonemes). No discontinuation criterion during the 12 test items was used. Cronbach's alpha for the different subtests ranged from 0.83 to 0.93.

Letter-sound knowledge. Children had to identify 20 letters presented simultaneously in upper- and lowercase (Cronbach's alpha = 0.95).

Receptive vocabulary. Children completed an adapted version of the Peabody Picture Vocabulary Test (PPVT-4; Dunn and Dunn, 2007). A predetermined fixed set of 40 items (i.e., uneven items from sets two to nine) were administered. Children were asked to identify a target picture out of four options to match a spoken word (Cronbach's alpha = 0.82).

Retelling. To assess children's narrative retelling skills and lexical knowledge, four pictures were laid out in sequence in front of the children while the examiner told the story (task adapted from Nielsen et al., in preparation). Immediately after listening to the story, children were asked to retell the story with support of the pictures. Children's narrations were transcribed using CHAT conventions and CLAN software was used to derive the total number of different words (TN_dW; MacWhinney, 2000). Ten percent of the narratives were coded by a second rater to assess inter-rater reliability. Inter-rater reliability for TN_dW was very high with an average ICC (absolute agreement) of 0.98 ($p < 0.001$).

RAN objects. An adapted version of the RAN task used by Fricke et al. (2016) was developed in Luxembourgish. Pictures of five objects were presented in a pseudo-random sequence over six rows of nine objects each. Children were asked to sequentially name as many objects as they could in 30 s (Cronbach's alpha = 0.94).

Verbal short-term memory. Children completed a computerized Luxembourgish version of the digit recall subtest of the Automated Working Memory Assessment (AWMA, Alloway, 2007; Engel de Abreu et al., 2010). Children were asked to immediately recall sequences of spoken digits, in the same order as they were presented. The test contained nine blocks of six items each. The span of digits increased progressively in each block by one digit. The test was discontinued after three non-consecutive mistakes within one block (Cronbach's alpha = 0.89).

Decoding. Children had to read twelve non-words. The non-words were similar to real words, but did not form a word in any of the four most common languages spoken in Luxembourg, i.e., Luxembourgish, German, French and Portuguese. The

length of the stimuli varied from two to four letters, each represented by four items. To be considered as read correctly, blending of the sounds was required and words had to be pronounced according to German/Luxembourgish sound-letter correspondence rules (Cronbach's alpha = 0.92).

Grade 1 measures in German

Single word and pseudoword reading. Children completed the German word and the pseudoword (word-like stimuli) reading subtests of the *Salzburger Lese- und Rechtschreibtest* [Salzburg Reading and Writing Test] (SLRT-II; Moll and Landerl, 2010). Children were presented the 72 first items of the word and non-word reading subtests and had one minute to read out loud as many items as possible (parallel forms of reliability reported from the test manual: 0.95 for word reading and 0.98 for non-word reading).

Spelling. Children completed the *Hamburger Schreibprobe + 1* [Hamburg Writing Sample for first graders] (HSP + 1; May, 2002). The test assesses orthographic knowledge and early spelling in children in Grade 1. Children were asked to write four words and a short sentence on a record sheet. The test was scored according to the manual, i.e., a point was awarded for each grapheme that was in the correct place with a maximum score of 40. For example, the correct spelling of the item < Nase > (nose) was awarded 4 points and a response such as < Nasi > was awarded 3 points (Cronbach's alpha = 0.92).

Results

Data inspection revealed skewed distribution with floor effects for the phonological awareness tasks on the individual phoneme level (i.e., phoneme blending, segmentation and manipulation) and for the decoding measure in preschool. Ceiling effects were observed for the syllable segmentation and rhyme identification tasks. These measures were subsequently dropped from further analyses due to limited variance (Kim, 2013). Literacy measures in Grade 1 presented skewed distributions and distributional normality was achieved by listwise deletion of one extreme outlier on the single word reading task ($>|6.0|$ *SD*) and by performing square root transformations for the reading measures and by log transforming the spelling measure (Tabachnick and Fidell, 2012). After listwise deletion of the extreme outlier, the analytical sample consisted of 88 children. Possible maximum scores, mean raw scores, standard deviations and ranges for all measures in preschool and in Grade 1 are presented in Table 1. For ease of interpretation, the tabled values are untransformed.

Measures tapping into the same underlying construct were transformed into single linear components using principal component analysis (PCA). The following three components were created: a phonological awareness component combining the phonological awareness onset-rime blending and the phonological awareness onset identification tasks; a lexical knowledge component combining the receptive vocabulary task and TN_dW of the retelling task; and a single word/pseudoword

Table 1 Descriptive statistics for predictor measures in preschool and literacy outcome measures in Grade 1 (N = 88)

	($N = 88$)		
	M	SD	Range
Socio-demographic measures			
Age (months)	75.00	3.93	69–88
SES (HISEI)	55.63	21.97	14–89
Preschool measures in Luxembourgish			
Syllable segmentation (12)	10.25	2.12	3–12
Rhyme identification (12)	9.22	3.20	0–12
Onset–rime blending (12)	6.78	3.98	0–12
Onset identification (12)	6.11	3.31	0–12
Phoneme blending (12)	2.88	3.34	0–12
Phoneme segmentation (12)	1.69	2.76	0–11
Onset/phoneme manipulation (12)	1.34	2.78	0–12
LSK (20)	9.92	6.48	0–20
Receptive vocabulary—PPVT (40)	31.58	5.06	17–39
Retelling—TN_dW	32.52	8.87	10–58
RAN—objects (54)	23.74	6.80	9–42
Verbal short-term memory (54)	20.87	4.76	1–34
Decoding (12)	1.25	2.91	0–12
Grade 1 literacy measures in German			
Word reading—SLRT II (72)	8.60	7.31	0–41
Pseudoword reading—SLRT II (72)	14.50	7.03	0–35
Spelling—HSP (40)	32.19	7.56	0–38

(), maximum raw scores; SES (HISEI), highest ISEI score of either caretaker or to the only available caretaker's score; LSK, letter-sound knowledge; PPVT, Peabody Picture Vocabulary Test; TN_dW, total number of different words; RAN, rapid automatized naming; SLRT II, Salzburger Lese- und Rechtschreibtest [Salzburg Reading and Writing test]; HSP + 1, Hamburger Schreib-Probe [Hamburg Writing Sample for first Graders]

reading component combining the SLRT II single word and pseudoword reading tasks (see Table S1 in the Supplemental Material for an overview of the measures of each component and PCA statistics). LSK, RAN, verbal short-term memory and spelling were kept as single indicators. The final set of preschool predictors consisted of age, SES, phonological awareness, RAN, verbal short-term memory, LSK and lexical knowledge in preschool. Outcome variables consisted of single word/pseudoword reading and spelling in German. To examine the relationships between socio-demographic and cognitive skills, concurrent and longitudinal zero-order correlations (Pearson's *r*) between the variables are presented in Table 2.

Correlation coefficients were interpreted following Cohen's guidelines of coefficients of 0.10–0.29 as weak, 0.30–0.49 as moderate, 0.50–0.79 as strong (Cohen, 1988). Chronological age did not show a significant correlation with

Table 2 Pearson's correlations between socio-demographic variables, preschool predictors, and Grade 1 literacy measures (N = 88)

	1	2	3	4	5	6	7	8
Socio-demographic variables								
1 Age in preschool								
2 SES	–.06							
Preschool predictors in Luxembourgish								
3 Phonological awareness	.17	.23*						
4 RAN	.29**	.25*	.52**					
5 Verbal short-term memory	.16	.23*	.51**	.57**				
6 LSK	.17	.27*	.52**	.50**	.49**			
7 Lexical knowledge	.11	.42**	.61**	.39**	.57**	.52**		
Grade 1 literacy skills in German								
8 Single word/pseudoword reading	.08	.22*	.59**	.46**	.43**	.53**	.42**	
9 Spelling	–.04	.27*	.61**	.39**	.41**	.51**	.50**	.79**

* = $p < .05$, ** = $p < .01$. SES, Socio-economic status; RAN, Rapid automatized naming; LSK, Letter-sound knowledge. Strength of correlations: very strong (.80–1), strong (.50–.79), moderate (.30–.49), weak (.10-–29), negligible (< .09)

any of the observed variables except for RAN ($r = 0.29$, $p = 0.006$). Correlations between SES and the cognitive measures were significant but weak (rs ranging from 0.22–0.27), except for the relationship between SES and lexical knowledge which was moderate ($r = 0.42$). Concurrent correlations between preschool predictors were all significant and ranged from moderate to strong (rs ranging from 0.39–0.61). Longitudinal correlations revealed that preschool predictors in Luxembourgish correlated moderately to strongly with literacy measures in Grade 1 learners (rs ranging from 0.39 to 0.61). Single word/pseudoword reading showed a strong correlation with spelling ($r = 0.79$).

Path analyses with maximum likelihood estimation were used to explore the unique contributions of the predictors. As a result of the pattern of insignificant or overall weak correlations between age and the literacy skills, age was not included in the final path models. To control for Luxembourgish oral language skills and SES in the exploration of unique contributions of the predictors to the literacy skills, lexical knowledge in Luxembourgish and SES were included as exogenous variables in the path models. Although we did not expect lexical knowledge in Luxembourgish in preschool to make independent contributions to literacy skills in German in Grade 1, children had different amounts of exposure to Luxembourgish in the home background and Luxembourgish is typologically close to German. Multivariate outliers in the data were examined using Mahalanobis distances and one case exceeding the critical Mahalanobis distance of 16.81 for a p-value of 0.010 and six degrees of freedom and was deleted (Tabachnick and Fidell, 2012). Due to sample size, path modelling with single indicators was used
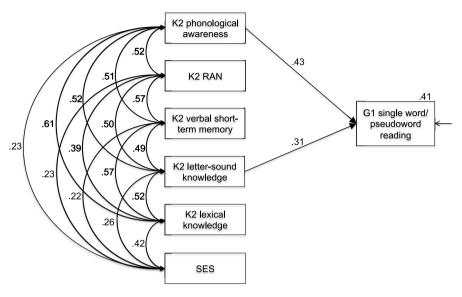
Fig. 1 Path analysis model predicting single word/ pseudoword reading in German in Grade 1 from preschool predictors in Luxembourgish K2 = Year 2 of Preschool; G1, Grade 1; RAN, rapid automatized Naming; SES, Socioeconomic Status. Fit indices: χ^2 (4, N=87)=2.552, p=.635, CMIN/DF=.638, CFI=1.000, TLI=1.050, RMSEA=.000 (CI$_{90}$=.000-.132)

(Kline, 2015). To improve model fit, all nonsignificant paths were deleted successively while observing fit indices to obtain parsimonious models. The simplified models with all nonsignificant paths dropped showed excellent fit to the data:

Predictors explained 41% of the variance in single-word/ pseudoword reading, χ^2 (3, N=87)=2.246, p=0.523, CMIN/DF=0.749, CFI=1.000, TLI=1.019, RMSEA=0.000 (CI$_{90}$=0.000-0.163), see Fig. 1;

Predictors explained 42% of the variance in spelling, χ^2 (3, N=87)=1.644, p=0.649, CMIN/DF=0.548, CFI=1.000, TLI=1.034, RMSEA=0.000 (CI$_{90}$=0.000-0.144), see Fig. 2.

Out of the six predictors, LSK and phonological awareness emerged as the only two unique predictors of the two literacy skills in this linguistically diverse sample. Preschool phonological awareness emerged as the strongest predictor of early single word/pseudoword reading (β=0.43, p<0.001) and of spelling in German (β=0.47, p<0.001). LSK emerged as the second strongest unique predictor for early single word/pseudoword reading (β=0.31, p=0.002) and spelling (β=0.26, p=0.007). Verbal short-term memory, RAN and lexical knowledge in Luxembourgish did not emerge as unique predictors for any Grade 1 outcome measure over and above LSK and phonological awareness.
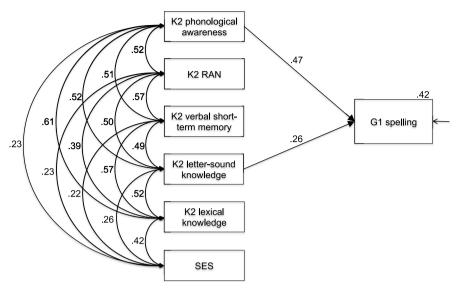
Fig. 2 Path analysis model predicting spelling in German in Grade 1 from preschool predictors in Luxembourgish. K2 = Year 2 of Preschool; G1, Grade 1; RAN, rapid Automatized Naming; SES, Socioeconomic Status. Fit indices: χ^2 (4, $N = 87$) = 2.316, $p = .678$, CMIN/DF = .579, CFI = 1.000, TLI = 1.057, RMSEA = .000 (CI$_{90}$ = .000-.126)

Discussion

This study explored the relationship between preschool foundational skills for literacy in Luxembourgish and reading and spelling skills in German in Grade 1 in the multilingual school context of Luxembourg. Children were assessed in Luxembourgish at the end of preschool and in German in Grade 1 after five months of literacy instruction. Findings suggest that literacy skills in Grade 1 in German can be predicted by phonological awareness, LSK, verbal-short term memory, RAN and lexical knowledge in Luxembourgish in preschool. However, only phonological awareness and LSK showed unique predictive value of Grade 1 reading and spelling.

Descriptive statistics revealed ceiling effects for the phonological task tapping larger phonological units (syllable segmentation and rhyme identification) but floor effects for the phonemic awareness tasks (phoneme blending, -segmenting and -manipulating). This observed pattern is in line with the developmental sequence of phonological awareness as awareness of larger phonological units generally proceeds the development of awareness of phonemes (Stackhouse and Wells, 1997). It is also not uncommon that children still show poor phoneme awareness skills in preschool before literacy instruction (Burgess and Lonigan, 1998; Carroll et al., 2003; Castles et al., 2011). On average children knew approximately ten letters at the end of preschool even without formal explicit teaching of letter-sounds. This could be a consequence of the implicit teaching

of foundational literacy skills in the preschool setting (MENFP, 2011), or LSK assessed before the formal introduction to literacy could reflect a proxy for the literacy environment at home. Studies have shown that some children acquire LSK prior to formal instruction through actively getting involved in home literacy activities with a focus on print, such as using letters, using alphabet books, etc. (Levy et al., 2006; Lukie et al., 2014). In the current study, children in preschool were not able to decode single words, which is unsurprising as literacy instruction is not part of the preschool curriculum (MENFP, 2011). The Grade 1 data after five months of literacy instruction revealed that, most children seem to have developed basic reading and spelling skills in German, which aligns with what has been observed in monolingual settings in Germany (Fricke et al., 2016; Seymour et al., 2003).

The longitudinal correlation analyses confirmed that individual differences in Grade 1 literacy skills in German are related to the foundational skills for literacy in Luxembourgish in preschool. This finding extends previous work highlighting the importance of foundational literacy skills in preschool for literacy development in monolingual contexts (Diamanti et al., 2017; Erdos et al., 2011; Georgiou, et al., 2012) to Luxembourgish children learning to read in German as an additional language. Notably, the pattern of longitudinal cross-linguistic relationships for both groups were stronger than observed in previous multilingual settings (Erdos et al., 2011; Melby-Lervåg and Lervåg, 2011). This is likely explained by the high degree of typological similarity between Luxembourgish and German (Gilles and Trouvain, 2013).

As expected, LSK emerged as a unique predictor of all Grade 1 literary components assessed. This confirms the strong predictive value of preschool LSK for different literacy components in German in Grade 1 (Fricke et al., 2016) and extends previous research to the multilingual context of Luxembourg (Caravolas et al., 2012; Erdos et al., 2011; Landerl et al., 2019; Lerner and Lonigan, 2016). This finding was also unsurprising as the 20 letter-sound correspondences assessed in the current study are identical in Luxembourgish and German and as the role of LSK in learning to read and spell is well understood (see Foulin, 2005).

Phonological awareness in Luxembourgish was a strong unique predictor of single word/pseudoword reading and spelling in German. The unique contribution of phonological awareness to word/pseudoword reading does not align with previous studies in German (Fricke et al., 2016; Wimmer et al., 2000). An explanation for this unexpected finding may be that all the children in the current sample followed literacy instruction in German as an additional language and previous work tentatively indicated that additional language learners may rely heavier and potentially for longer on decoding skills than their peers acquiring literacy in their first language (Chiappe et al., 2002; Jongejan et al., 2007). A possible delayed shift from alphabetic to more efficient orthographic reading in children learning to read and spell in an additional language, compared to children acquiring literacy in their first language, may explain why children in the current study still relied on alphabetic decoding skills, whereas German-speaking first graders in Germany at the same stage of literacy acquisition seem to have advanced further towards orthographic reading (Fricke et al., 2016). The current findings suggest that the view of

phonological awareness being less important for reading development in consistent orthographies than in more inconsistent orthographies does not automatically apply for children learning to read in an additional language (Ziegler et al., 2010). With regards to spelling, the emergence of phonological awareness as a strong contributor to individual differences in spellings in Grade 1 aligns with previous work that has identified phonological awareness as a reliable predictor of spelling across European orthographies with varying degrees of consistency (Caravolas et al., 2012; Georgiou et al., 2008) and in German (Fricke et al., 2016). The importance of phonological awareness for spelling in German has mainly been explained by the less consistent phoneme to grapheme correspondences in the direction of spelling than the grapheme to phoneme correspondences in the direction of reading (Landerl and Wimmer, 2008; Ziegler et al., 2010).

Although RAN objects in preschool showed moderate longitudinal correlations with single word/pseudoword reading and spelling in Grade 1, RAN did not account for unique variance in the two literacy measures. This is contrary to findings from previous work in German where RAN accounted for unique variance in word reading and spelling in Grade 1 (Fricke et al., 2016; Landerl et al., 2019; Moll et al., 2009). However, these studies have included either a RAN colour task in addition to the RAN objects task in preschool (Fricke et al., 2016), or employed a RAN digits task with children who have already started primary school (Landerl et al., 2019; Moll et al., 2009). Although Lervåg and Hulme (2009) clearly showed that non-alphanumeric RAN tasks can also be strong independent predictors of literacy acquisition, it is well understood that alphanumeric RAN tasks are more predictive of literacy outcomes than non-alphanumeric tasks (Araújo et al., 2015; Georgiou et al., 2008). Unfortunately, due to a lack of robust familiarity with letters and digit names of preschool children in Luxembourg, no alphanumeric RAN task could be administered in the current study to further explore this hypothesis. Another possible explanation of why RAN did not account for unique variance in the current study aligns with the explanation above of why phonological awareness was predictive of word reading skills. Children in the current sample are still in a very early phase of literacy acquisition in an additional language and they may still employ slower alphabetic reading strategies over more efficient orthographic strategies. It would be important to further follow-up the children to explore whether preschool RAN becomes predictive of more advanced orthographic reading and spelling in higher grades (Fricke et al., 2016; Landerl and Wimmer, 2008).

The longitudinal correlations support a role of preschool verbal short-term memory as an important component of literacy development (Engel de Abreu and Gathercole, 2012; Peng et al., 2018), however, verbal short-term memory did not emerge as a unique predictor for any literacy component in the current study. The current findings support the hypothesis that verbal short-term memory does not account for unique variance over and above foundational skills more specifically related to processes involved in reading and spelling in a multilingual setting (Melby-Lervåg et al., 2012; Savage et al., 2007; Van den Broek et al., 2016).

Lexical knowledge in Luxembourgish presented longitudinal correlations with reading and spelling in German, however, it did not emerge as a unique predictor in the path models. This aligns with previously observed limited direct effects of

lexical knowledge on literacy development in the early phase of literacy acquisition in monolingual (Fricke, et al., 2016; Lervåg and Aukrust, 2010; Muter et al., 2004) and multilingual settings (Erdos et al., 2011; Harrison et al., 2016). Nevertheless, a follow-up study would be informative as children's oral language skills have been found to influence the course of literacy development in higher grades with measures tapping reading comprehension (Melby-Lervåg and Lervåg, 2014; Nation and Snowling, 2004). As linguistic proximity is central to cross-linguistic relationships and Luxembourgish and German share many features, it could be conjectured that the lexical knowledge in Luxembourgish predicts individual differences in more advanced text-level reading comprehension in German.

A strength of this study is that it longitudinally explores the importance of a broad range of foundational skills in Luxembourgish in preschool for different literacy outcomes in German in children growing up in Luxembourg. However, the study has limitations beyond statistical constraints due to its sample size. Firstly, although all children in the sample acquired literacy in German as an additional language, the complex linguistic situation in Luxembourg makes it difficult to examine how much exposure to German children have had. For example, some children may have watched German TV at home (Gilles, 2020) which may have influenced results on reading and spelling skills in German in Grade 1. The linguistically diverse setting also makes it difficult to control for typologically proximity between the home language and the language of instruction German. It could be argued that children who mainly speak another Germanic language at home (such as English or Dutch) find it easier to acquire literacy in German than children who mainly speak a Romanic language at home (such as French or Portuguese). Therefore, although a moderate amount of variance was accounted for by the predictors, future work could also include other predictors that possibly account for variance in literacy development in Luxembourg such as environmental, family factors and linguistic proximity of the home language to the language of literacy instruction (Heath et al., 2014; Hofslundsengen et al., 2019; Odlin, 1989). Secondly, findings could have been strengthened by including multiple indicators per domain of interest (such as a RAN colour task or a non-word repetition task). Thirdly, any strong cross-linguistic conclusions should be made with caution due to the non-experimental study design. Further follow-up work could also investigate the association between the preschool predictors and more advanced writing and spelling skills in higher grades (as done by Landerl and Wimmer, 2008).

Conclusion

This study presented data from a multilingual school context in Luxembourg in which the language of reading instruction is not the main spoken language in the country. Results clearly showed that individual differences in literacy development in an additional language can be predicted by foundational skills in another language before formal literacy instruction begins in a linguistically diverse sample. Findings

are consistent with the view that literacy development in an additional language builds upon similar key building blocks as literacy acquisition in monolingual settings. However, results suggest that respective contributions and predictive relationships between preschool predictors and literacy skills may slightly vary in children learning to read in an additional language. Future research is clearly needed to further investigate literacy development in an additional language in other contexts and to also explore the importance of typological similarities between languages for literacy development in multilingual settings.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11145-021-10239-1.

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