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Exploring cross-language transfer among children in multilingual education: a longitudinal study in Luxembourg

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ABSTRACT

This longitudinal study explores cross-language transfer among children attending multilingual public schools in Luxembourg, where Luxembourgish is the instruction language in preschool and German the language of instruction in elementary school. Following 132 children from preschool (age 5) to grade 2 (age 7), annual assessments were conducted to evaluate their vocabulary proficiency in both Luxembourgish and German. Bilingual learners were systematically classified based on theoretically motivated criteria, encompassing home language background and Luxembourgish language proficiency. Longitudinal analyses were carried out employing linear mixed models and multigroup path modeling, targeting both monolinguals and various groups of bilingual learners. The results provide robust support for the presence of cross-language transfer between Luxembourgish and German. Notably, Luxembourgish vocabulary proficiency in preschool emerged as a significant predictor of subsequent German proficiency for both monolingual and bilingual learners. Furthermore, bilingual learners with lower Luxembourgish vocabulary in preschool exhibited compromised German vocabulary in elementary school. These findings underscore the importance of cross-language transfer theories and their implications for multilingual education practices in Luxembourg.

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Cross-language transfer; longitudinal; Luxembourgish; German; multilingual education practices

Introduction

Luxembourg, a small European country located between France, Belgium, and Germany, and home to just over half a million inhabitants, is known for its rich linguistic diversity characterized by three official languages: Luxembourgish, German, and French. Luxembourgish, in addition to being one of the official languages, is also the national language and is spoken across the country. It is the native language for the majority of the Luxembourgish population (Fehlen et al. 2021). Notably, Luxembourg has the highest proportion of non-national citizens in the European Union, comprising 58% of the population (Eurostat 2022), with over two-thirds of parents using multiple languages with their children (MENJE 2018; Service national de la jeunesse 2023). The public school system implements multilingual education, with instruction in Luxembourgish, German, and French during the elementary years. While this multilingual system offers many benefits, it also presents challenges, particularly in second-language instruction. Understanding the potential transfer effects between the various school languages is crucial for optimizing the timing and methodologies

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of language instruction. This paper specifically focuses on the transfer effects between Luxembourgish and German, which serve as the primary instructional languages in the early school years, ultimately aiming to enhance language learning outcomes and ensure effective multilingual instruction in Luxembourg's unique educational context.

Language instruction plays a crucial role in Luxembourg´s elementary education, accounting for approximately 44% of total teaching time (MENFP 2011). As a result, academic success is largely influenced by students' performance in language classes. The elementary curriculum is officially trilingual, incorporating Luxembourgish, German, and French at different stages of instruction. Within the population, Luxembourgish remains the most widely spoken language (48.9%), followed by Portuguese (15.4%) and French (14.9%), while only 2.9% of the population identifies German as their dominant language (Fehlen et al. 2021). Luxembourgish is often regarded as the language of social integration in Luxembourg, while German is mainly used in written contexts, and French plays a key role in administration.

In public preschools, Luxembourgish serves as the primary language of instruction. The preschool curriculum emphasizes a play-based approach, focusing on social and developmental skills. Code-based literacy instruction begins in grade 1 of elementary school. There is no direct equivalent to preschool as seen in other countries, such as the U.S.; instead, children transition from preschool to first grade at age six, where the language of instruction shifts to German and formal literacy education in German commences. Given Luxembourg's small size, the linguistic similarities between Luxembourgish and German (both West Germanic languages), and the limited availability of written materials in Luxembourgish, reading instruction at this level is conducted entirely in German (Horner and Weber 2008). Both oral and written German are introduced in grade 1, while formal instruction or oral Luxembourgish is minimal, occurring in just one lesson per week. In the early grades, instruction in German oral language skills and literacy accounts for approximately 39% of total instructional time, with German also serving as the language of instruction for other subjects. French, the third instructional language, is gradually introduced throughout the elementary years. In grades 1 and 2, students receive minimal instruction in French, which progressively increases as they reach the higher grades, such as Years 5 and 6 (MENFP 2011).

Luxembourgish is a Moselle Franconian language belonging to the Germanic language family and is closely related to Standard German (Newton 1996). It also incorporates a considerable number of words of French origin (Kartheiser 2000). According to Stephens (1976), Luxembourgish is as distinct from Standard German as Dutch is. Importantly, due to their shared Germanic roots, Luxembourgish and German exhibit similar phonological features, cognate vocabulary, and structural similarities (Gilles 2023). Given these linguistic similarities between the two languages, it has long been assumed that transfer effects occur between Luxembourgish and German, and the language curriculum in the early school years is structured around this assumption. However, the transfer hypothesis between Luxembourgish and German has yet to undergo empirical investigation and has recently been challenged (Hoffmann et al. 2018; Hornung et al. 2023).

Research on cross-language transfer in second language learners typically aligns with either the contrastive analysis account (Lado 1964) or the interdependence hypothesis (Cummins 1979). The contrastive analysis hypothesis suggests that transfer is facilitated by linguistic similarity, particularly in cognate vocabulary and phonological forms (De Angelis 2007; Rothman 2011). For instance, Barking, Backus, and Mos (2022) have demonstrated that typological similarity plays a crucial role in determining the cross-language transfer between the two Germanic languages German and Dutch. The linguistic interdependence hypothesis, proposed by Cummins (2008; 2017), suggests that the ability to transfer skills and knowledge between languages is dependent on a shared underlying proficiency. Similarly, Macswan and Rolstad (2005) argue that various languages provide learners with access to a shared store of knowledge, irrespective of the language through which that knowledge was initially gained. The 'facilitation theory' suggests that language is linked to conceptual knowledge developed in school, with transfer referring to the accessibility of information across linguistic domains, independent of the language in which the knowledge was originally acquired

(Rolstad and MacSwan 2014). The forementioned transfer and facilitation frameworks converge on the idea that linguistic transfer occurs to varying degrees; nonetheless, the transfer process is inherently complex, requiring particular conditions to facilitate effective transfer. Specifically, existing theories assert that two key conditions must be met for skills from language X (Lx) to be successfully transferred to language Y (Ly): (1) instruction in Lx must effectively develop Lx skills, and (2) learners must have adequate exposure to and motivation for acquiring Ly (Cummins 2000). Additionally, various other factors, including developmental processes, levels of language and literacy proficiency, and language typology play a crucial role in shaping language transfer (for a comprehensive overview, see Genesee, Geva, et al. 2006; Genesee, Lindholm Leary,et al. 2006).

Rossell and Baker (1996) challenge transfer and facilitation theories, proposing that time-on-task in a second language is the pivotal factor influencing achievement in second-language learners. This perspective suggests that increased time spent in the school language correlates with higher language achievement, akin to a competition model where time allocated to learning one language diminishes learning in another (Quiroz, Snow, and Zhao 2010). The time-on-task assumption has faced scrutiny (Bialystok 2018; MacSwan et al. 2017). Notably, research within the U.S. context has shown that English learners in dual language programs achieve comparable or higher levels of academic proficiency than their counterparts in English-only programs (Lindholm-Leary and Genesee 2010). A latent variable study by MacSwan et al. (2017) demonstrated that home language literacy (Spanish) significantly predicted academic achievement in the school language (English) beyond English language proficiency among English Language Learners. Beyond North America, a study involving monolingual and bilingual toddlers from Norway (Gunnerud, Reikerås, and Dahle 2018) directly explored the time-on-task hypothesis. The results indicated that while Norwegian-speaking monolinguals outperformed bilinguals in Norwegian language comprehension, there was no proficiency difference between bilinguals who primarily spoke Norwegian at home and those using a combination of Norwegian and another language at home. However, bilinguals from households with no exposure to Norwegian scored significantly lower. The authors suggest that the variability in second language skills among bilinguals may not be explained by the time-on-task hypothesis. Instead, they propose the existence of a threshold value of second language input required to attain proficiency, rather than a linear relationship between exposure time and second language skills.

While theories on language transfer and time-on-task are extensively documented for first – and second-language learners (Genesee et al. 2006; Goldenberg 2011), there is a dearth of research exploring cross-language transfer among trilingual children acquiring multiple second languages in a school context. A recent Luxembourg study challenges the language transfer account for the typologically close languages Luxembourgish and German, advocating for early and intense exposure to German in Luxembourg preschools, aligning with the time-on-task principle (Hornung et al. 2023). Analyzing data from Luxembourg's national student assessments (ÉPSTAN), Hornung et al. (2023) investigated first graders' performance in Luxembourgish and German listening comprehension during the first term of grade 1. Participants were grouped into distinct cohorts based on home language background: 'Luxembourgish' (comprising 32% of the sample), 'Portuguese' (16%), and 'French' (12%). The results revealed a discrepancy in performance patterns among the different groups. Specifically, children from the 'Luxembourgish' group performed better in German than in Luxembourgish. In contrast, the Portuguese and French cohorts evinced a contrasting trend, manifesting notably inferior scores in German comprehension relative to their Luxembourgish. Based on these disparities, the authors conclude that there is no evidence of language transfer from Luxembourgish to German among non-Luxembourgish-speaking children. Therefore, the authors strongly recommend the implementation of German language instruction in preschool for all children in Luxembourg as a crucial policy measure.

Other research from Luxembourg lends support to the notion of language transfer between Luxembourgish and German. For example, Wealer et al. (2022) established a correlation between early literacy skills in Luxembourgish during preschool and subsequent literacy proficiency in German by

grade 1 in multilingual children. Moreover, Engel de Abreu, Fricke, and Wealer (2020) conducted a controlled intervention study, demonstrating that targeted support for early literacy skills in Luxembourgish resulted in enhanced reading comprehension in German by grade 1, encompassing both Luxembourgish and non-Luxembourgish speaking children. Considering the limited exposure of Portuguese – and French-speaking children in Hornung et al. (2023) to Luxembourgish and their recent introduction to German in a school setting, asserting the absence of Luxembourgish-German transfer seems premature. This highlights a significant gap in the existing literature, underscoring the necessity for further studies to address this issue and provide evidence-informed insights for decision-making.

The present study aims to address this gap. Utilizing longitudinal data from multilingual children in Luxembourg followed from the second year of preschool to grade 2 of elementary school, the study explores the following research questions:

RQ1. What are the differences in Luxembourgish vocabulary in preschool, in grade 1, and in grade 2, between different groups of bilingual children with varying levels of Luxembourgish home language exposure?

RQ2. What are the differences in German vocabulary in grade 1 and in grade 2 between children from bilingual homes with high and lower levels of Luxembourgish proficiency in preschool?

RQ3. What are the associations between bilingual children's Luxembourgish vocabulary knowledge in preschool and their vocabulary knowledge in German in elementary school in grade 1 and grade 2?

Participants were systematically classified into distinct bilingual groups, employing criteria tailored to the research questions. A comprehensive analytical strategy encompassed both between-group and correlational data analysis methods. The tested hypothesis proposed that bilingual children exposed to Luxembourgish at home would outperform those without such exposure in their home language environment. Consistent with the transfer hypothesis, it was anticipated that bilingual learners with higher proficiency in Luxembourgish oral language would demonstrate proficient German oral language skills, while those with lower proficiency in Luxembourgish would exhibit poorer German oral language skills. Furthermore, it was predicted that cross-language associations between Luxembourgish and German vocabulary knowledge from preschool to grade 1 and grade 2 would manifest using a longitudinal path analysis approach.

Methods

The study adhered to the Helsinki Declaration's Code of Ethics (1975, revised 2013) and received ethical approval from the University of Luxembourg's Ethics Review Panel. Permissions were obtained from the Ministry of Education, school administrative directors, and teachers. Assessments were conducted with informed consent from legal guardians and assent from children.

Participants

Participants were drawn from 14 classrooms across eight small to medium-sized public preschools located in rural areas of central and northern Luxembourg. These eight schools were selected from two of Luxembourg's 15 educational districts. Schools were chosen to ensure uniformity in terms of infrastructure, socioeconomic status, teaching methods, curriculum, teacher-student ratios, and the proportion of non-Luxembourgish-speaking students. Two children whose parents primarily spoke German were excluded from analysis. Data from 132 children (43% girls) were analysed across three time points: the end of preschool year 2 ($M_{age} = 6;3$), mid-grade 1 ($M_{age} = 6;10$), and end of grade 2 ($M_{age} = 8;2$). Parental education levels and home language backgrounds were obtained via parental questionnaires, revealing an average parental schooling of 14.59 years ($SD = 3.31$). All children had received two years of preschool instruction in Luxembourgish at the first assessment time point.

Procedure

Children completed individual vocabulary tests in Luxembourgish during preschool, grade 1, and grade 2, and in German during grade 1 and grade 2. Additionally, cognitive ability assessments were conducted in Luxembourgish during preschool. Test administration was categorized by language, and administrators were fluent or native speakers of Luxembourgish and German. Since there were no established norms for the administered tests in Luxembourg, raw scores were utilized in all analyses. Internal consistency of the measures was determined based on the sample and is detailed below.

Measures

Family background questionnaire: Legal guardians/parents completed a questionnaire available in Luxembourgish, German, and French. It covered various topics such as child demographics, early milestones, educational history, home language usage, and caregiver information (occupation, education level, languages spoken to the child). The highest education level of either caregiver was used as an estimate of family socioeconomic status (SES).

General cognitive abilities. The matrix reasoning subtest of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI III, Wechsler 2007) was administered as a measure of nonverbal reasoning. Children have to complete figures by identifying the missing piece among four or five possible drawings (Cronbach's alpha = .82). Children also completed two computerized verbal and visual-spatial simple span tasks as assessments of working memory (Engel de Abreu, Conway, and Gathercole 2010). In the verbal *digit recall* task children listen to sequences of digits and are asked to verbally repeat the sequences with the same presentation order (Cronbach's alpha = .89). In the visuo-spatial *dot matrix* task, children see a moving dot within a four-by-four matrix and are asked to remember the location of the dot by pointing to the locations in an empty grid in the correct sequence (Cronbach's alpha = .87).

Receptive vocabulary. Children completed both Luxembourgish and German versions of the Peabody Picture Vocabulary Test (Lenhard et al. 2015). They heard a word spoken by the examiner and selected the corresponding picture out of a set of four options. Different sets of items were used for the Luxembourgish and German versions. The German version followed standardized procedures outlined in the manual (Lenhard et al. 2015, Cronbach's alpha = .98). However, for the Luxembourgish version, which lacks standardization, a fixed set of 40 items was administered (Cronbach's alpha = .82).

Data analysis

Children were categorized based on information gathered from the family background questionnaire regarding the primary language spoken by their parent(s) to them. Those whose parents exclusively spoke Luxembourgish were classified as 'monolinguals in Luxembourgish' (Mo-LU). Children exposed to languages other than Luxembourgish from one or both parents were categorized as 'bilinguals' (Bi). Following Gunnerud, Reikerås, and Dahle (2018), the bilingual group was further divided into 'Luxembourgish and another language' (Bi-LU&Other), where one parent spoke Luxembourgish and the other spoke a different language to the child; and 'mostly non-Luxembourgish' (Bi-NoLU), where both parents spoke a non-Luxembourgish language to the child. Additionally, bilingual children were classified based on their performance on the Luxembourgish vocabulary measure in preschool relative to the full sample. Children scoring at or below the 33rd percentile were designated as 'lower-level Luxembourgish bilinguals' (Bi-LowLU), while those scoring above the 33rd percentile were categorized as 'higher-level Luxembourgish bilinguals' (Bi-HighLU).

Linear mixed effects (LME) models were conducted in R (R Core Team 2022) to longitudinally compare the language performances of the different groups using the lmerTest package (Kuznetsova, Brockhoff, and Christensen 2017). The most parsimonious LME model structure was determined using

a maximum likelihood estimation method and a 'bobyqa' optimizer. In a step-wise procedure, random effects were added to an unconditional growth model and retained only if they improved model fit according to chi-square statistics and Akaike's Information Criterion (West, Welch, and Galecki 2007). Statistical significance of fixed effects was determined with the Kenward-Roger wiWald statistic and Satterthwaite approximation of degrees of freedom. Differences among groups were further explored using Sidak-adjusted post-hoc post-hoc tests in the emmeans package (Lenth 2021). The MuMIn package (Bartón 2019) was used to compute model fit indices (pseudo R^2).

To explore the cross-linguistic association between Luxembourgish in preschool and German in grade 1 and grade 2, multigroup path analyses were performed on the covariance structure using AMOS (Arbuckle 2017) with a maximum likelihood estimation method. As structural equation modeling is based on large sample theory (Kline 2015), no bilingual subgroups were created for these analyses, and all children who spoke another language than Luxembourgish to one or both parents included in the bilingual category. The initial analysis involved estimating an unconstrained model to the data for the full sample, followed by testing model with constraint path coefficients for the monolingual and the bilingual groups.

Results

A total of 14 different home languages were spoken by parents to the children in the sample (N = 132): 48% (n = 64) were classified as Mo-LU, 23% (n = 30) as Bi-Lu&Other, and 29% (n = 38) as Bi-NoLu. Within the Bi-Lu&Other group, 37% (n = 11) had one parent speaking Luxembourgish and the other speaking Portuguese, while 20% (n = 6) had one parent speaking Luxembourgish and the other speaking French. In the Bi-NoLu group, 45% (n = 17) had both parents speaking Portuguese, and 18% (n = 7) had both parents speaking French. Among the 68 bilingual children, 44% (n = 30) were Bi-LowLU. In the Mo-LU group, all but one child were born in Luxembourg. In the Bi-Lu&Other group, all children were born in Luxembourg. In the Bi-NoLu group, 85% of the children were born in Luxembourg. Among the 10 children in this group who were not born in Luxembourg, the average age at which they relocated to Luxembourg was 18.9 months (range: 4–36 months), with 7 out of the 10 children having moved to Luxembourg before or at the age of 24 months.

Mo-LU children had significantly higher family SES compared to bilingual children, whose SES did not differ between groups. To ensure comparability based on SES, a subset of 32 Mo-LU children was selected using a median split approach. Descriptive statistics for the language groups are presented in Table 1. Independent t-tests revealed no differences in language measures or background variables (age, SES, non-verbal reasoning) between children whose mother or father spoke Luxembourgish to them (*p*s ranging from .113 to .880).

Research question 1

> What are the differences in Luxembourgish vocabulary in preschool, in grade 1, and in grade 2, between different groups of bilingual children with different Luxembourgish home language exposure?

A series of one-way ANOVAs showed no differences between the Mo-LU, the Bi-LU&Other, and the Bi-NoLU groups in terms of age, SES, non-verbal reasoning and working memory capacity (*p*s ranging from .131 to .942). Given equivalence between the groups, those variables were not included as covariates in the LME analysis. The LME model included time-point (coded as numeric), language group (the Mo-LU group was dummy coded as the reference group), and a time point × language group interaction term as fixed effects. The addition of a random slope for time point (repeated measurements nested within participants) yielded significantly improved fit relative to an unconditional growth model containing only a random intercept for child ($\Delta\chi^2 = 16.946$, $\Delta df = 2$, $p > .001$). The model satisfied assumptions concerning homogeneity of variance,

Table 1. Mean, n (SD, %) for demographic characteristics, cognitive and language measures for the different groups.

	Monolingual groups		Bilingual groups				
				Classification based on home language use		Classification based on Luxembourgish vocabulary in preschool	
	Monolinguals Luxembourgish (Mo-LU)	Monolinguals Luxembourgish equivalent in SES to Bilinguals	Bilinguals (Bi)	Bilinguals Luxembourgish & other language (Bi-LU&Other)	Bilinguals No Luxembourgish (Bi-NoLU)	Bilinguals High Luxembourgish (Bi-HighLU)	Bilinguals Low Luxembourgish (Bi-LowLU)
n	64	32	68	30	38	38	30
Age (months)							
Preschool	75.02 (3.96)	74.59 (3.88)	75.62 (4.40)	74.37 (3.45)	75.22 (3.78)	75.37 (3.83)	74.55 (4.02)
Grade 1	82.36 (3.95)	82.07 (3.77)	82.19 (3.68)	81.76 (3.39)	82.56 (3.92)	82.57 (3.81)	81.93 (4.10)
Grade 2	99.00 (3.45)	98.73 (3.69)	97.89 (3.45)	97.60 (3.57)	98.17 (3.39)	99.02 (3.67)	96.60 (2.95)
Gender (female)	23 (36%)	14 (44%)	30 (44%)	14 (47%)	16 (42%)	32 (48%)	12 (36%)
Socioeconomic status							
Years of parental schooling	15.59 (2.44)	13.78 (1.74)	13.77 (3.77)	13.66 (3.15)	13.88 (4.30)	13.97 (3.46)	13.50 (4.21)
General cognitive abilities							
Nonverbal reasoning (29)	14.40 (3.80)	15.34 (4.26)	14.21 (4.10)	14.40 (3.80)	14.76 (4.33)	15.82 (3.09)	12.17 (4.35)
Verbal WM (54)	22.55 (3.90)	22.31 (4.49)	20.35 (3.65)	20.67 (3.25)	20.67 (3.25)	21.54 (3.05)	18.97 (3.85)
Visuo-spatial WM (42)	16.01 (3.69)	15.59 (2.73)	15.09 (3.58)	16.00 (2.67)	14.31 (4.09)	15.81 (3.85)	14.21 (3.05)
Receptive vocabulary Luxembourgish (40)							
Preschool	33.47 (5.17)	33.28 (5.44)	25.69 (5.41)	27.40 (5.04)	24.34 (5.37)	29.63 (2.87)	20.70 (3.13)
Grade 1	34.61 (4.30)	34.61 (3.64)	28.85 (4.64)	30.30 (4.25)	27.64 (4.66)	32.06 (3.07)	25.00 (3.13)
Grade 2	36.58 (2.16)	36.41 (2.34)	31.63 (4.08)	32.72 (3.99)	30.71 (3.97)	34.26 (2.95)	28.36 (2.67)
German (228)							
Grade 1	119.90 (24.77)	122.24 (23.80)	87.67 (20.82)	94.03 (24.15)	82.24 (15.93)	98.54 (19.04)	74.07 (13.93)
Grade 2	150.69 (14.99)	148.74 (15.01)	118.50 (22.90)	126.27 (21.44)	111.38 (22.27)	127.43 (19.74)	101.75 (19.02)

Note: () = possible maximum scores; WM = working memory; Mo-LU = both parents speak Luxembourgish to the child; Bi = bilinguals; Bi-LU&Other = one parent speaks to the child in Luxembourgish and the other parent speaks a different language to the child; Bi-NoLU = both parents both speak a language other than Luxembourgish to the child; Bi-LowLU = bilingual children who score at the 33rd percentile on Luxembourgish vocabulary; Bi-HighLU = bilingual children who score above the 33rd percentile on Luxembourgish vocabulary.

Table 2. LME model of Luxembourgish vocabulary for the different home language groups (time point 1 – time point 3).

Fixed Effects	Estimate	*SE*	95% CI	*t*-value	*p*
Intercept	32.08	1.15	[29.82, 34.31]	27.80	< .001
Time point	1.31	0.33	[0.66, 1.97]	3.93	< .001
Home Language: Monolinguals Luxembourgish (Mo-LU) vs Bilinguals Luxembourgish & Other (Bi-LU&Other)	−5.63	1.66	[−8.86, −2.40]	−3.40	< .001
Home Language: Monolinguals Luxembourgish (Mo-LU) vs Bilinguals No Luxembourgish (Bi-NoLU)	−10.51	1.56	[−13.56, −7.45]	−6.71	< .001
Time point x Bilinguals Luxembourgish & Other (Bi-LU&Other)	0.50	0.48	[−0.43, 1.43]	1.06	.291
Time point x Bilinguals No Luxembourgish (Bi-NoLU)	1.72	0.45	[0.84, 2.60]	3.80	< .001
Random effects	**Variance**	***SD***			
Child (intercept)	32.24	5.68			
Time point | Child (slope)	1.24	1.11			
Residual	4.31	2.08			

Note: N participants = 100; N observations = 290; Pseudo R^2: marginal = .367; conditional = .870; Mo-LU = both parents speak Luxembourgish to the child; Bi = bilinguals; Bi-LU&Other = one parent speaks to the child in Luxembourgish and the other parent speaks a different language to the child; Bi-NoLU = both parents speak a language other than Luxembourgish to the child.

approximately normal distribution of residuals, and multicollinearity. The final LME model for Luxembourgish vocabulary growth of the different home language groups is shown in Table 2.

The three home language background groups differed significantly in their intercepts. Relative to the Mo-LU reference group, both the Bi-LU&Other and the Bi-NoLU group exhibited significantly lower intercepts in Luxembourgish vocabulary. Children in the Bi-NoLU group presented a significantly lower intercept than children in the Bi-LU&Other group. Although all language groups showed a significant rate of progress over time, children from the Bi-NoLU group made a significantly faster rate of growth in Luxembourgish vocabulary than children from the Mo-LU group and the Bi-LU&Other group (see Figure 1). Post-hoc tests with Sidak corrections revealed significant differences in Luxembourgish vocabulary between the three groups at each time point, except between the Bi-LU&Other and the Bi-NoLU groups at time point 3 (p = .055), where children from the Bi-NoLU groups seem to catch up with children from the Bi-LU&Other group. However, both the Bi-LU&Other and the Bi-NoLU group show significantly

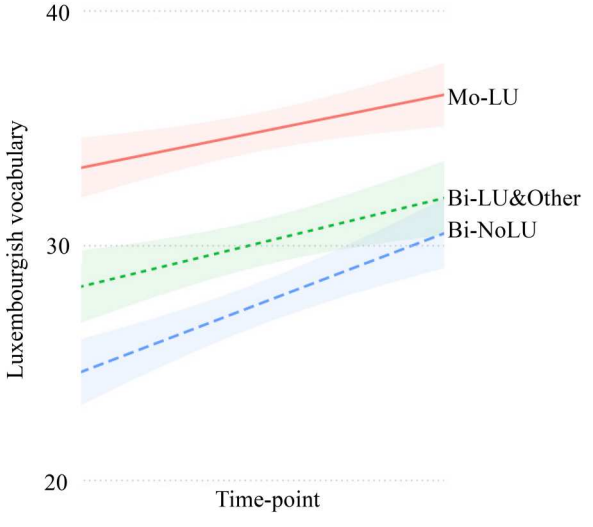

Figure 1. LME model of Luxembourgish vocabulary for Mo-LU, Bi-LU&Other and Bi-NoLU (time point 1 – time point 3).

lower performances in Luxembourgish vocabulary relative to the Mo-LU reference group at time-point 3.

Research question 2

What are the differences in German vocabulary in grade 1 and grade 2 between children from bilingual homes with high-and lower-levels of Luxembourgish proficiency in preschool?

A series of independent *t*-tests showed no significant differences in age, SES, and visuo-spatial working memory between the Bi-LowLU and the Bi-HighLU groups (*p*s ranging from .441 to .648). However, children in the Bi-LowLU group showed significantly lower performances in nonverbal reasoning ($p < .001$) and verbal working memory ($p = .015$) compared to children in the Bi-HighLU group. The two measures were included as covariates in the LME analyses. With just two time point, no random slope for time point could be fitted and the LME model therefore included only a random intercept for child. The final LME model for German vocabulary growth of the different bilingual Luxembourgish language proficiency groups is shown in Table 3.

The two groups differed significantly in their intercepts: the Bi-highLU group significantly outperformed the Bi-lowLU group in German vocabulary. The two groups presented a significant rate of progress over time (see Figure 2). However, the two groups did not differ significantly in their rate of progress over time and at time point 3, the Bi-highLU group still significantly outperformed the Bi-lowLU group.

Table 3. LME model of German vocabulary for two different bilingual Luxembourgish language proficiency groups (time point 2 – time point 3).

Fixed Effects	Estimate	*SE*	95% CI	*t*-value	*p*
Intercept	66.21	14.48	[69.81, 136.48]	4.47	< .001
Time point	27.43	2.48	[22.49, 32.37]	11.57	< .001
Verbal working memory	−0.33	0.59	[−1.56, 0.91]	2.74	.008
Nonverbal reasoning	0.11	0.58	[−1.11, 1.34]	−.021	.834
Bilinguals Low Luxembourgish (Bi-LowLU) vs Bilinguals High Luxembourgish (Bi-HighLU)	−25.29	4.82	[−33.79, −13.20]	−4.54	< .001
Time point * Bilinguals Low Luxembourgish (Bi-LowLU)	0.82	4.17	[−6.66, 10.02]	0.33	.745
Random effects	**Variance**	***SD***			
Child (intercept)	181.30	13.46			
Residual	91.30	9.56			

Note: N participants = 62; N observations = 107; Pseudo R^2: marginal = .610; conditional = .869; Bi-LowLU = bilingual children who score at the 33rd percentile on Luxembourgish vocabulary; Bi-HighLU = bilingual children who score above the 33rd percentile on Luxembourgish vocabulary.

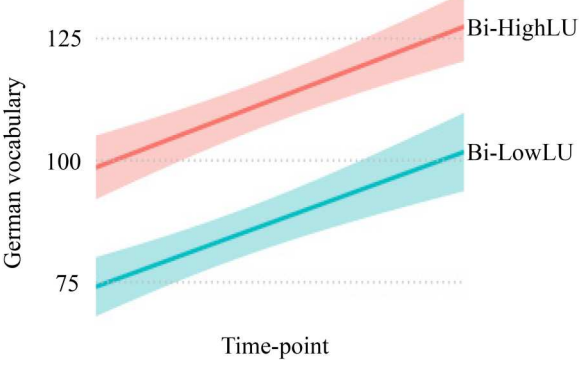

Figure 2. LME model of German vocabulary for Bi-HighLU and Bi-LowLU (time point 2 – time point 3).

Research question 3

What are the associations between bilingual children's Luxembourgish vocabulary knowledge in preschool and their vocabulary knowledge in German in elementary school in grade 1 and grade 2?

Longitudinal zero-order correlations between SES, Luxembourgish vocabulary in preschool, and German vocabulary in grade 1 and grade 2 for the full sample and for language groups (monolingual or bilingual) are shown in Table 4. For the full sample (N = 132), SES showed a weak significant correlation with Luxembourgish in preschool and moderate significant correlations with German in grade 1 and grade 2. Luxembourgish in preschool correlated strongly with German in grade 1 and in grade 2. For the monolingual subgroup (n = 64), Luxembourgish in preschool showed moderate correlations with German in grade 1 and in grade 2. For the bilingual group (n = 68), the correlations between Luxembourgish in preschool and German in grade 1 and grade 2 were strong to very strong.

The path model included two exogenous variables (Luxembourgish vocabulary in preschool and SES) and two endogenous variables (grade 1 and grade 2 German vocabulary). To control for SES, covariances were specified between SES and Luxembourgish in preschool and grade 1 German. A visual representation of the model, including parameter estimates of the different tested models, can be seen in Figure 3. For model evaluation, commonly used goodness-of-fit indices were interpreted according to established cut-off guidelines (Kline 2015). Indicative of good fit are: CMIN/DF values < 3 (Bollen 1989); CFI and IFI values > .90 (Hoyle 1995); RMSEA values < .08 (McDonald and

Table 4. Pearson correlation coefficients between SES, Luxembourgish in preschool vocabulary, and grade 1 – and grade 2 German vocabulary for the full sample, and the monolingual and the bilingual subgroups.

		Full sample ($N = 132$)				Monolingual ($n = 64$) and bilingual ($n = 68$) subgroups[1]			
	Variables	1	2	3	4	1	2	3	4
1	SES						.13	.20	.18
2	Preschool-Luxembourgish	.27**				.17		.33*	.41**
3	Grade 1 German	.31**	.69**			.29*	.66**		.38**
4	Grade 2 German	.34**	.78**	.73**		.20	.73**	.81**	

Note: [1]coefficients above diagonal = monolinguals (n = 64), coefficients below diagonal = bilinguals (n = 68). Strengths of correlation coefficients: .10 – .29 weak, .30 – .49 moderate, .50 – .79 strong (Cohen, 1988);
* = $p < .05$, ** = $p < .01$.

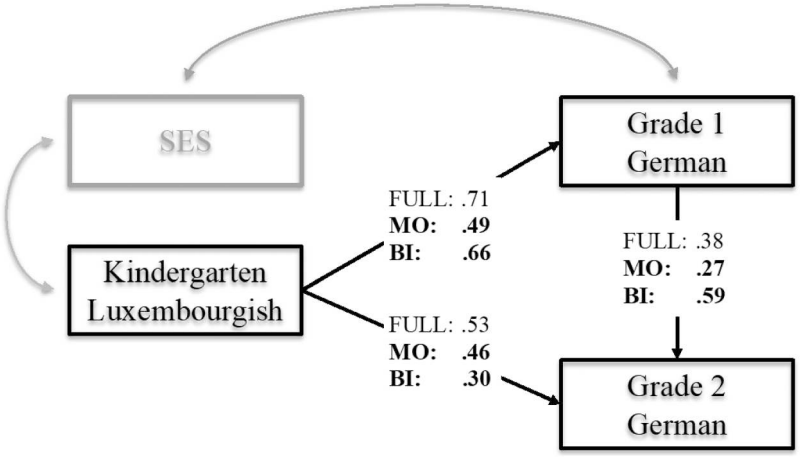

Figure 3. Path analyses model predicting German vocabulary in grade 1 and grade 2 from Luxembourgish vocabulary in preschool for the full sample (FULL), and the monolingual (MO) and bilingual (BI) subgroups.

Note: FULL = model for full sample (N = 132), MO = model for monolinguals (n = 64), BI = model for bilinguals (n = 68).

Ho 2002). Goodness-of-fit indices for all the tested models, including chi-square difference tests are presented in Table 5.

The model on the full sample (N = 132) showed satisfactory fit to the data: $\chi^2(1, N = 132) = 2.32$, $p = .128$, CMIN/DF = 2.32, CFI = .993, IFI = .993, RMSEA = .100 (CI90 = .000 – .277), with significant and strong associations between Luxembourgish in preschool with German in grade 1 ($\beta = .71$, $p < .001$) and German in grade 2 ($\beta = .53$, $p < .001$). To explore whether the relationship between variables in the model differed between monolingual and bilingual children, multi-group path modeling was used. A multi-group model with unconstrained parameter estimates for the monolingual and bilingual groups presented an excellent fit to the data: $\chi^2(1, N = 132) = 1.23$, $p = .540$, CMIN/DF = .617, CFI = 1.000, IFI = 1.007, RMSEA = .000 (CI90 = .000 – .151). The chi-square difference test between the full sample and the unconstrained multi-group models was non-significant ($\Delta\chi^2 = 1.11$, $p = .292$). Path coefficients revealed significant associations for both groups between: Luxembourgish in preschool and German in grade 2 (monolinguals: $\beta = .46$, $p < .001$; bilinguals: $\beta = .30$, $p = .008$); German in grade 1 to German in grade 2 (monolinguals: $\beta = .27$, $p = .035$; bilinguals: $\beta = .59$, $p < .001$); and for or the mediating path from Luxembourgish in preschool to German in grade 1 ($\beta = .49$, $p < .001$; bilinguals: $\beta = .66$, $p < .001$).

The data did not fit a multi-group model with all path coefficients constrained to be invariant across the two groups (structural weights constrained), $\chi^2(5, N = 132) = 12.91$, $p = .032$, CFI = .928, IFI = .826, RMSEA = .105 (CI90 = .028 – .182). This indicates that although a comparable pattern of association exists between the Mo – and Bi group, the strength of the associations is non-equivalent between the two groups. To determine on which path coefficient(s) the models differ, a stepwise approach was used in which individual path coefficients were sequentially constrained while allowing the other path coefficients to be non-invariant. Results indicate that the model with the constrained path coefficient German in grade 1 to German in grade 2 provides a poor fit to the data (see Table 5). Comparison of the parameter estimates indicates a stronger association between German in grade 1 and grade 2 for the Bi group ($\beta = .59$) than for the Mo group ($\beta = .27$). The path coefficients from Luxembourgish in preschool to German in grade 1 and grade 2 can, however, be considered equivalent across the Mo and Bi groups.

Table 5. Goodness-of-fit indices and chi-square difference tests for all tested models.

	Model chi-square						
Model	*N*	χ^2	df	*p*	CFI	IFI	RMSEA (90% CI)
Total sample	132	2.34	1	.129	.993	.993	.100 (.000-.277)
Monolingual group	64	1.166	1	.280	.987	.992	.051 (.000-.343)
Bilingual group	68	0.066	1	.797	1.000	1.010	.000 (.000-.207)
Multi-group models							
Multi-group: all path coefficients non-invariant between models	132	1.23	2	.540	1.000	1.007	.000 (.000-.151)
Multi-group: all path coefficients Multi-group: all path coefficients constrained to be invariant across models	132	12.191	5	.032	.928	.826	.105 (.028-.182)
Multi-group models with one path coefficient constrained							
Multi-group: constrained path K2-G2	132	1.24	3	.743	1.000	1.015	.000 (.000-.104)
Multi-group: constrained path K2-G1	132	1.42	3	.701	1.000	1.014	.000 (.000-.110)
Multi-group: constrained path G1-G2	132	10.76	3	.013	.922	.933	.142 (.057-.236)
Model comparisons	$\Delta\chi^2$	Δdf	*p*				
$Model_{Full\ sample} - Model_{Multi\text{-}group\ non\text{-}invariance}$	1.11	1	.292				
$Model_{Full\ sample} - Model_{Multi\text{-}group\ invariance}$	9.85	2	.007				
$Model_{Multi\text{-}group\ non\text{-}invariance} - Model_{Multi\text{-}group\ invariance}$	10.56	3	.012				
$Model_{Multi\text{-}group\ non\text{-}invariance} - Model_{constrained\ path\ K2\text{-}G2}$	.01	2	.995				
$Model_{Multi\text{-}group\ non\text{-}invariance} - Model_{constrained\ path\ K2\text{-}G1}$	.19	2	.91				
$Model_{Multi\text{-}group\ non\text{-}invariance} - Model_{constrained\ path\ G1\text{-}G2}$	9.53	2	.008				

Note: FULL = model for full sample (N = 132); K2 = preschool; G1 = grade 1; G2 = grade 2.

Discussion

This study aimed to evaluate cross-language transfer between Luxembourgish and German, both languages of instruction, in children learning multiple second languages at the elementary school level in Luxembourg. Bilingual learners were categorized according to different theoretically motivated criteria allowing to empirically explore specific research questions situated in different theoretical frameworks (Cheng et al. 2021). Findings address both theoretical and practical concerns. Theoretically, enhancing our understanding of cross-language effects in bilingual learners contributes to the development of a comprehensive theory of bilingual language development. Practically, discerning the circumstances under which cross-language influences impact language learning is vital for designing interventions to support second language acquisition.

The study compared the Luxembourgish language proficiency of children with varying degrees of exposure to Luxembourgish at home. Similar to findings in Norway (Gunnerud, Reikerås, and Dahle 2018), results suggest that the variability in second language skills among bilinguals may not be solely explained by the time-on-task hypothesis. Children exclusively exposed to Luxembourgish at home outperformed bilingual groups in Luxembourgish vocabulary. However, the difference in Luxembourgish vocabulary between bilingual children with some exposure to Luxembourgish at home and children with no Luxembourgish exposure at home disappeared from preschool to grade 2. One possible explanation for this trend could be the positive impact of schooling on Luxembourgish oral language development among bilingual children. Increased exposure to Luxembourgish in preschool may have equalized initial differences in Luxembourgish language skills among bilingual groups with varying levels of Luxembourgish exposure at home by grade 2.

The findings of this study align with language transfer theories (Cummins 2000; De Angelis 2007; Macswan and Rolstad 2005), which propose that development in one language can facilitate academic growth in another. Such notions are integral to bilingual education policies in Luxembourg, where children initially immerse themselves in Luxembourgish in preschool and subsequently acquire literacy in German starting in first grade.

Firstly, we found that bilingual children with lower Luxembourgish vocabulary in preschool also demonstrated lower German vocabulary scores in grades 1 and 2 compared to bilingual children with higher Luxembourgish vocabulary scores. Secondly, our path model results revealed that Luxembourgish vocabulary proficiency in preschool significantly predicted German vocabulary scores one and two years later, regardless of whether the children came from bilingual or monolingual homes. Remarkably, Luxembourgish vocabulary proficiency in preschool remained a significant predictor of German vocabulary in grade 2, even after controlling for German proficiency in grade 1. Furthermore, our multigroup analyses showed similar associations between Luxembourgish and German for both monolingual and bilingual children. Interestingly, we observed a stronger association between German proficiency in grade 1 and grade 2 among bilingual children compared to Luxembourgish monolinguals. This finding warrants further investigation in future studies. It is plausible that for bilingual children, German language acquisition is predominantly influenced by school instruction, while factors outside of school (e.g. exposure to German media, travel to Germany) may also contribute to language development among monolingual Luxembourgish-speaking children.

Our findings from both between-group and individual difference analyses support the contrastive analysis account of cross-linguistic transfer (Lado 1964; Rothman 2011) and are consistent with prior research on cross-language transfer between other Germanic languages, particularly German and Dutch (Barking, Backus, and Mos 2022). This suggests that linguistic proximity influences language associations, supporting the notion of language facilitation between Luxembourgish and German. While causality cannot be definitively established from the data, the results clearly indicate a relationship between Luxembourgish and German vocabulary skills in both monolingual and bilingual children. These findings challenge recent assertions suggesting no transfer between Luxembourgish and German (Hoffmann et al. 2018; Hornung et al. 2023) in bilingual learners. Our

results regarding language transfer are consistent with previous findings of cross-linguistic associations between Luxembourgish and German, particularly in the realm of early literacy skills (Engel de Abreu, Fricke, and Wealer 2020; Wealer et al. 2022). These findings collectively suggest a nuanced relationship between Luxembourgish and German language development, emphasizing the importance of considering cross-linguistic influences in bilingual language acquisition contexts.

The study has several limitations beyond statistical constraints due to its sample size that should be acknowledged. Firstly, bilingual children were not assessed in their first language, precluding investigation into language transfer between bilinguals' first and second languages. Additionally, the quality and quantity of Luxembourgish home language input were not directly assessed; instead, parental language use served as a proxy for input quantity. Furthermore, the study only utilized one measure of oral language-vocabulary – which limits the generalizability of findings to other language domains. Future studies should incorporate additional language measures to address this limitation. Although it remains unclear what exactly renders typologies 'sufficiently similar' to facilitate language transfer between two languages in a specific context, greater structural similarity between languages has been found to increase cross-language transfer (Barking, Backus, and Mos 2022; Odlin 2022). Future research is needed to explore cross-language transfer between typologically more distant languages than Luxembourgish and German.

Despite these limitations, the study possesses notable strengths. These include its longitudinal design, thorough control of covariates, and theoretically driven research questions (Genesee et al. 2006; Genesee et al. 2006). Moreover, the study provides a comprehensive description of the sociolinguistic context and study population, in line with recommendations for transparent and thorough reporting of participant characteristics in bilingualism research (Surrain and Luk 2019). Conducted in Luxembourg, this research extends the evidence base beyond English-speaking countries, contributing valuable insights to bilingualism research in diverse linguistic contexts (Castro 2014; Hammer et al. 2014).

Implications and conclusion

The complexity and diversity of factors influencing bilingual education underscore the inadequacy of a one-size-fits-all approach. Various variables, including the typology of the languages of instruction, timing of exposure, teaching methodologies, curriculum design, and broader societal factors such as language ideologies and linguistic diversity, significantly impact language acquisition and educational outcomes (Bialystok 2018; Spolsky 2004).

In the specific sociolinguistic context of Luxembourg, it is crucial to clarify the objectives of multilingual education and the criteria used to evaluate its effectiveness, particularly in relation to achieving trilingualism throughout elementary school. If the primary goal is to prioritize proficiency in German, then an early introduction of German in preschool, as suggested by Hornung et al. (2023), may be appropriate. However, if the overarching aim is to foster proficiency in all three official languages – Luxembourgish, German, and French – to promote comprehensive societal participation, alternative approaches could be explored. As emphasized by Spolsky (2004) and Hornberger (2002), effective language policies must consider societal language ideologies and community practices. In Luxembourg, where political discourse is conducted in Luxembourgish and proficiency in this language is essential for citizenship – which encompasses full voting rights – and many job positions, it is vital for language education strategies to adequately prepare children for active participation in civic life and the job market.

The proposition to introduce additional languages into Luxembourgish preschool has sparked considerable debates, particularly as preschool is the primary stage for Luxembourgish instruction. Given Luxembourgish's role as the 'language of integration' and the limited time dedicated to its instruction in elementary schools, there are concerns regarding potential adverse effects of reducing Luxembourgish exposure in preschool on achieving trilingualism, especially for children with minimal exposure to Luxembourgish outside of school.

Our findings, which resonate with those of Hornung et al. (2023), reveal significant disparities in Luxembourgish proficiency between bilingual children and their Luxembourgish monolingual peers. Consequently, reduction in Luxembourgish instruction time to introduce German during preschool should be thoroughly investigated through well-designed studies before broader implementation. To effectively address these disparities, it is essential to initiate rigorously designed studies that monitor progress across diverse outcome measures and assessments in multiple instructional languages. Such research will provide decision-makers with robust evidence to inform their choices regarding language learning and teaching practices, helping them determine the most effective strategies for supporting language acquisition within a trilingual educational context.

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