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Early Childcare Attendance, Home Language, and Listening Comprehension: Evidence from Large-Scale Assessments in Multilingual Luxembourg

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ABSTRACT

Research Findings: Research indicates that early childcare is beneficial for children's language skills. Children from minority home language groups especially benefit from an early start. In this study, we investigated the association between early childcare attendance (ages 0 to 4 years) and listening comprehension in the language of instruction in multilingual Luxembourg. In particular, we analyzed whether this association was moderated by home language. Multilevel regression analyses on large-scale school monitoring data revealed that results depended on the home language group. Early childcare attendance, especially for a duration of 3 years, was positively associated with listening comprehension in the language of instruction among children who did not speak that language at home. Children who already spoke the language of instruction at home, monolingually or multilingually, did not benefit from childcare attendance or duration to the same extent. *Practice or Policy*: Our results extend the previous evidence on the potential of childcare to reduce disparities in the language of instruction, which is key for academic progress and success. These findings may guide stakeholders in monitoring and enhancing the quality of the language environment in early childcare settings, which could provide better starting points for children in linguistically diverse school populations.

Introduction

Early childhood is a critical period for children's cognitive, linguistic, physical, and socio-emotional development. Attending early childhood education and care (ECEC), especially high-quality ECEC settings, has been shown to have positive effects on various cognitive outcomes, including mathematics, reading, and language development (Camilli et al., 2010; DeAngelis et al., 2020; Lazzari & Vandenbroeck, 2012).

Language skills are key in nearly all situations across the lifespan (UNESCO, 2005). Especially skills in the language of school instruction and school-related literacy skills are important for further schooling – without them, children cannot process and connect to the school's input (Cummins, 2021; Schleppegrell, 2001). Proficiency in the language of instruction explains some of the achievement gaps between students of different home language backgrounds. For example, education reports often show that children who do not speak the language of instruction (or a similar language) at home perform worse on literacy tests than students who grow up with the language of instruction at home (UNESCO, 2016; Van Staden et al., 2016).

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The threshold hypothesis (Cummins, 1979) proposes a benchmark level of language proficiency that bi- or multilingual students must attain to avoid difficulties in literacy acquisition. Accordingly, researchers have underlined that for these dual or multiple language learners, early contact with rich oral input in the language of instruction is essential to promote literacy skills (Byers-Heinlein & Lew-Williams, 2013; Gogolin & Neumann, 2009). Therefore, in contexts where children grow up multilingual, the onset of learning the language of instruction is crucial, and the critical period for successful childhood bilingualism is set before school age (Moser et al., 2008; Schulz & Grimm, 2019; cf. Tracy, 2008). Therefore, participation in ECEC may be particularly beneficial for multilingual children.

However, not all ECEC settings are the same. Generally, ECEC for older children (ages 3 to 5 years) is supported by more literature showing consistently positive outcomes (e.g., academic achievement, cognitive, and language outcomes) than early childcare services for younger children (ages 0 to 3 years), which have been investigated less frequently and have yielded more mixed results (Melhuish et al., 2015). Characteristics of ECEC attendance, such as duration, have also been shown to impact its effects (Del Boca et al., 2022; Li et al., 2020).

In Luxembourg, a considerable portion of the student population grows up multilingual, and many children struggle with the language of instruction, which can cause them to lag behind their peers academically (Greisen et al., 2021; Hornung et al., 2021). ECEC in Luxembourg has already been recognized as key to facilitating language learning, which is why high-quality ECEC for 4- and 5-year-olds has been obligatory for all students since 1992. However, as it is recommended that children learn the language of instruction as early as possible (Tracy, 2009), we aimed to investigate not only attendance but also how time spent in voluntary early childcare before the age of four is related to language skills in the language of instruction for children of different linguistic backgrounds. More specifically, our study examines children's listening comprehension which, as a receptive language skill, is a prerequisite for academic success and predicts later reading comprehension skills (Hogan et al., 2014; Lervåg et al., 2018). Childcare duration in years represents one way to operationalize childcare dosage, alongside other indicators such as age of entry, session duration, and frequency of attendance (Wasik & Snell, 2019). In this study, the duration and age of entry are, however, intertwined. Long durations are only possible with early entry, but short durations are, though unlikely, also possible with an early entry into childcare. Thus, we include literature on both duration and age of entry in the following literature review.

General associations between early childcare and listening comprehension

In the early years, children's brains are developing fast and are thus especially malleable and sensitive to stimuli from the outside, such as experiences or environmental influences (Center on the Developing Child at Harvard University, 2016). Thus, attending childcare that offers safe and nurturing caregiving, engages children in playful activities, and provides rich, responsive language interactions can foster the acquisition of key language skills (Hoff, 2006; Schoch et al., 2023). For example, daily opportunities to communicate with caregivers and peers in the language of instruction – combined with its stimulation through playful activities such as storytelling or nursery rhymes – can encourage and promote children's receptive and expressive language development (Incognito & Pinto, 2023).

Data from the Early Childhood Longitudinal Study in the U.S. (Loeb et al., 2007) show that children's language skills at age five, measured as a composite score including receptive language skills, improved when children had attended center care at age four or earlier instead of Head Start or other forms of non-parental care. Next to attendance itself, the retrospective study also examined the duration of attendance in years and found that more years in center care were positively correlated with short-term language outcomes. However, greater benefits were found when children started between ages 2 and 3 years, indicating a curvilinear relationship, with the best results observed at a moderate childcare duration.

This curvilinear trend is further supported by findings from the large-scale, longitudinal EPPSE/EPPNI study in the United Kingdom (Sylva et al., 2004). Each additional month of ECEC experience after age two was associated with better intellectual development, including both receptive and expressive language, at ages three and five. Thus, each month children started before the age of 3 years was associated with better scores; however, starting before the age of 2 years did not have any additional effect.

These curvilinear patterns might go back to the special vulnerability of children in the earliest years, as age-specific needs of pre-speech infants include a high responsiveness and reliability of caregivers (Fort et al., 2016), which may be hard to provide in an often short-staffed ECEC sector (Meisch & Hahn, 2025).

However, this does not mean positive childcare effects for the youngest children are not possible: Benefits of an earlier entry into center care also emerged in a study by Yazejian and colleagues (2015), who evaluated the effects of a targeted ECEC program (Educare) for under-6-year-olds of low-income families in the U.S. Receptive language abilities measured by the Peabody Picture Vocabulary Test (PPTV-4) between ages 3 and 5 years were higher when children entered care centers at a younger age or attended for more years. However, the effects of entry age and duration of attendance were confounded in this study. To disentangle these effects, Soliday Hong et al. (2023) compared the receptive language skills of children who started this program between ages 1.5 to 3 years with those of children who started later, between ages 3 to 4 years. They found that children who started center care as toddlers had better receptive language skills (at age 3 to 4 years) compared to their peers who started later, even with a longer duration of attendance. This indicates it is indeed the entry age that drives this positive effect.

This conclusion is further supported by a meta-analysis by Li et al. (2020) who find that specialized ECEC programs for disadvantaged children in the U.S. between 1960 and the early 2000s that started in infancy had larger effect sizes than those that only started in the preschool years. Conversely, longer programs had smaller average effect sizes than shorter programs that took fewer years. This suggests an alternative explanation for the curvilinear patterns observed in childcare duration effects. If an early start is not inherently detrimental, a longer duration may indicate that children have already "max[ed] out" (Wasik & Snell, 2019, p. 35) the benefits of a particular childcare service – especially if it lacks an age-appropriate curriculum or fails to provide further stimulating and developmentally challenging experiences. In such cases, children might benefit more from transitioning to a different ECEC environment that better aligns with their evolving needs (Li et al., 2020; Wasik & Snell, 2019).

Moderated effects

Similar to studies showing greater benefits for children from less advantaged families (e.g., low socioeconomic status, Davies et al., 2021; or migration background; Felfe & Lalive, 2014), stronger associations between childcare attendance and duration and school-related listening comprehension can be expected for students who speak other languages than the language of instruction at home. These children may not only benefit from having an early start and additional time with the language of instruction through their childcare attendance but may also particularly profit from a varied and rich language environment in childcare settings. This is especially relevant if their parents lack the resources to provide a similarly stimulating linguistic experience in the language of instruction at home (McCabe et al., 2013). Interaction quality in ECEC has fittingly proven particularly relevant for the majority language development of multilingual students (Willard et al., 2021).

Moderated effects were indeed found for targeted ECEC programs for low-income students in the U.S., such as Educare. More years in the program, as well as starting at toddler age (ages 1.5 to 3 years) rather than at preschool age (ages 3 to 4 years), was found to be more strongly associated with higher receptive language skills for dual language learners than for single language learners (Soliday Hong et al., 2023; Yazejian et al., 2015).

This pattern is further supported by studies on universal ECEC (ages 0 to 5 years) in Germany (Kohl et al., 2019). Here, an early entry age benefited all students' receptive language skills in the language of instruction, measured between ages 2 and 6 years. Moreover, stronger effects were found for dual language learners with low exposure to the language of instruction at home compared to both single language learners and dual language learners who also spoke the language of instruction at home. Thus, the group with the lowest language scores benefited the most from starting earlier, which helped to narrow the gap between the language groups.

Country setting

The present study is situated in the multilingual context of Luxembourg, which features a heterogeneous, highly attended, and financially accessible ECEC system (Bollig et al., 2016; Honig, 2015; OECD, 2022). Early childcare is provided in universal childcare centers ("crèches") for children from birth to the age of 4 years. Attendance rates are high, as children under 3 years are more than twice as likely to attend early childcare than the OECD average (OECD, 2022). For example, 63% of children under age three in Luxembourg attended early childcare in 2021 (Eurostat, 2024), with a modal attendance of 31 to 40 hr per week (Hornung et al., 2023). Childcare in Luxembourg is also highly affordable, as centers are subsidized by a voucher system that guarantees 20 free hours of childcare per week for all children. Further hours are subsidized depending on parental income. As the high demand for ECEC spots cannot be met by public services alone, the country also has a large private childcare sector, which includes both nonprofit and commercial services (Wiltzius & Honig, 2015). Children below the age of four tend to be enrolled in commercial, for-profit settings: in 2023, nearly 50% of this age group attended a commercial setting, while 15 to 20% attended publicly financed settings (OECD, 2022; Simoes Loureiro & Neumann, 2024). Next to these categories, ECEC in Luxembourg can also be separated into a non-formal (childcare centers or family care by parental assistants) and a formal ECEC sector which encompasses a voluntary preschool year from ages 3 to 4 years ("précoce"), and the two mandatory years of preschool from ages 4 to 6 years ("Cycle 1") in public schools. ECEC in Luxembourg has thus been named a "double split system" (Bollig et al., 2016, p. 78), referring to both non-formal and formal, as well as both private and public services, resulting in a great heterogeneity in services and service quality (OECD, 2022). This is also reflected in the diverse qualification requirements for ECEC staff: Teachers in mandatory preschool hold a bachelor's degree in educational sciences. In voluntary preschool, one teacher with a bachelor's degree works in tandem with one caregiver with a vocational training background. Staff in childcare are required to have a vocational training, a diploma in education, art, music, language, or motor skills, or a basic training to develop pedagogical skills (Meisch, 2025). Employees in early childcare are furthermore required to speak at least one or two[1] of the three official languages (Luxembourgish, German, and French). Childcare centers also have some flexibility in the languages they offer. Languages range from the three mandatory official languages to others such as Portuguese and English, the most prominent languages besides the official languages. As a result, multiple languages are often spoken in childcare (MENJE, 2016), highlighting the linguistic diversity in Luxembourg's ECEC system.

Research on ECEC in Luxembourg has so far focused primarily on these multilingual practices (e.g., Kirsch & Aleksić, 2021). Nevertheless, recent results on the effectiveness of ECEC (ages 0 to 6 years) have indicated small yet positive associations between attendance in different ECEC settings and Luxembourgish listening comprehension (LLC) in first grade, as well as some selection effects showing children from families with lower socioeconomic status and a first-generation migration background attended childcare for a shorter duration than their peers. In addition, children of Portuguese-speaking families were more likely to attend childcare than children of monolingual Luxembourgish-speaking families and attended for a longer duration (Hornung et al., 2023). However, we still have a limited understanding of how early childcare in this multilingual context affects children from

different language backgrounds – particularly the effect of whether or not their home language matches the language of instruction.

Generally, Luxembourg's trilingual national school system is characterized by a high proportion of immigrants (United Nations, 2020) and a culturally diverse student population. A significant proportion of the student population (43%) does not have the Luxembourgish nationality, and an additional proportion (67%) does not speak Luxembourgish at home (MENJE & SCRIPT, 2022). As a result, many students grow up multilingually, exposed to various home languages, and are subsequently introduced to the three languages of instruction: Luxembourgish in preschool, German in primary school, and French in secondary school. This language policy across the curriculum places significant demands on both students and schools and leads at least partly to the notable disparities in academic achievement (Hornung et al., 2021; Sonnleitner et al., 2021).

As multilingualism plays an increasingly important role in our globalized world (Grosjean, 2018; Hong & Cheon, 2017) and "the kaleidoscope of diversities is here to stay" (Vandenbroeck, 2018, p. 411), findings from the diverse and multilingual context of Luxembourg may offer valuable insights to other countries.

Present study

This study aims to address two research questions. First, (RQ1) what is the relationship between early childcare (ages 0–4 years) and listening comprehension in the language of instruction[2] in first grade? As outlined above, early childcare can offer an early rich language environment with responsive interactions, rich language, and playful activities that encourage and promote children's receptive and expressive language development (Center on the Developing Child at Harvard University, 2016; Incognito & Pinto, 2023). Therefore, we expect a positive association between both attendance and duration of early childcare and children's LLC. We expect associations between childcare and the language of instruction to be weaker than those in international findings, due to the multilingual nature of childcare. The high number of languages included in Luxembourgish childcare services beyond the instructional and home language may lead to less time-on-task with the measured language Luxembourgish (Godwin et al., 2021).

Due to the overlap of 1 year of childcare with the voluntary preschool year and high needs for quality and 1:1 care in the first year of life (Bowlby, 2007; Fort et al., 2016), attendance in the first year, and the last year of childcare may not be associated with better child development. We therefore expect to observe the highest scores at a moderate duration of 2 years, after which additional years of childcare do not lead to higher scores, similarly to previously reported curvilinear trends of duration (Loeb et al., 2007; Sylva et al., 2004).

Second, (RQ2) how does the relationship between both early childcare attendance and duration and LLC differ for children with a different home language background?

Consistent with the findings of Kohl et al. (2019), we expect the association between early childcare and LLC to be moderated by children's home language background. Kohl et al. (2019) differentiated between dual-language-learner groups with high and low exposure to the language of instruction and only found a significant moderation effect of childcare in regard to the dual language group with low exposure to the language of instruction at home. Similarly, we examined three home language groups with varying levels of language of instruction use at home: 1) monolingual children who only speak the language of instruction at home (MonoLI), 2) multilingual children who speak the language of instruction and a second language at home (MultiLI), and 3) multilingual children who do not speak the language of instruction at home (NonLI). Greater benefits are expected for NonLI than MonoLI and MultiLI. For NonLI, attendance and longer duration in childcare may be crucial for developing skills in the language of instruction (Byers-Heinlein & Lew-Williams, 2013), as it provides an early exposure to and opportunity to speak the language of instruction. Besides the quantity of language input, childcare may also offer a child-tailored, responsive, and rich language environment in which young children from diverse family backgrounds develop their language skills more easily

(McCabe et al., 2013). We expect MultiLI students who use the language of instruction at home next to others to show no significant differences from the MonoLI group.

Methods

Procedure

The data used in this study were collected as part of the Luxembourg School Monitoring Programme Épreuves Standardisées (ÉpStan) in November 2021. The ÉpStan refer to a comprehensive large-scale assessment conducted each fall in first, third, fifth, seventh, and ninth grades, testing the attainment of curriculum objectives in the previous 2 years. In primary schools, the ÉpStan include pen-and-paper achievement tests and questionnaires for students and parents handed out by the class teacher, providing a standardized record of students' skills in key academic domains. These assessments thereby represent a valuable longitudinal data source within the Luxembourgish education system. All public schools in Luxembourg participate in the ÉpStan. The program has a proper legal basis and is approved by the national committee for data protection. Appropriate ethical standards were adhered to (APA, 2017). Prior to data collection, students and their parents or legal guardians are duly informed and have the possibility to opt-out. This study did not require ethical approval according to local legislation and institutional requirements, as it was a secondary data analysis of an existing dataset. To ensure students' privacy in accordance with the European Data Protection Regulation, the present analysis was conducted with an anonymized dataset.

Participants

While the 2021 cohort comprised $N = 5{,}952$ students, available data on all relevant variables was found for $n = 3{,}813$ first graders (49.9% female, 50.1% male) grouped in 410 classes in 166 primary schools in Luxembourg. Our sample comprised 134 students (5.7%) who were off track and had taken more than 2 years to complete learning cycle 1 (2 years of compulsory preschool), which explains the age range of 5 to 9 years ($M = 6.4$ years).

Measures

Luxembourgish listening comprehension (LLC)

The dependent variable for our analyses was LLC. The standardized test in ÉpStan assessed the oral understanding of vocabulary and syntax as well as the comprehension of texts on well-known topics, such as, for instance, family, school, and animals. The test comprised 31 items assessing the comprehension of two conversations with three speakers each, two short stories, and one short factual text. The standardized test was administered in the classroom in November of the first grade after 2 months of formal schooling. Children's responses were collected in paper-and-pencil booklets. The test took 35 min, during which verbal instructions and test content were presented on a CD or an audio streaming platform. The resulting ÉpStan scores were Rasch-scaled to a mean of 500 and a standard deviation of 100. They were also anchored to the ÉpStan performances in the previous years. The test difficulty for the 31 items ranged between −1.85 and 1.39, with a mean of −0.27. Thus, the test was relatively easy. The items with a mean infit of one, ranging between 0.86 and 1.19, fit well to the Rasch model. Further summary statistics on the IRT analysis are provided in the Appendix.

Early childcare

For the key variables, attendance and duration of early childcare, we used information from the parent questionnaire, which was provided in German, French, Portuguese, and English. Parents were asked how many years their children had attended a childcare center (early non-formal ECEC for ages 0 to 3 years) before they started compulsory preschool at age four (response in full years). At age 3, childcare

attendance can overlap with attendance in the voluntary preschool year. In the first block of our analyses, the childcare duration information was used to form a dichotomous variable indicating whether childcare had been attended. In the second block, we included duration of childcare in years as a metric variable and a quadratic term to account for a curvilinear relationship.

Home language group

Information on the moderating variable home language was collected through the student questionnaire, where first graders were asked to select the language they spoke most frequently with their mother and father, respectively. This questionnaire was administered by the teachers in Luxembourgish. Based on this information, they were classified into three possible language groups: MonoLI, i.e., they only spoke the language of instruction Luxembourgish (or German)[3] with their parents; MultiLI, if they spoke Luxembourgish (or German), and also at least one other language with their parents; and NonLI, if they spoke one or multiple other languages at home that did not include Luxembourgish (or German). As shown in Table 1, approximately 32% belonged to the MonoLI group, 16% were in the MultiLI group, and a slight majority of 52% spoke neither of these two languages at home (NonLI).

Age, gender, migration background, and socioeconomic status

We included age, gender, migration background, and socioeconomic status as controls since these variables can be related to both ECEC attendance and LLC. Age was calculated by subtracting the birth year, obtained from an administrative database, from the assessment year 2021. Gender was self-reported by the students. Migration background was assessed in the parent questionnaire by questions about the parents' and child's birth country. If the child and at least one parent were born in Luxembourg, the child was categorized as native. Otherwise, they were first-generation (child and

Table 1. Descriptives.

Student Variables	Definition	Mean	*SD*	Min	Max	Missing %
Luxembourgish listening comprehension	Test score in Luxembourgish listening comprehension	514.55	103.87	103.21	858.09	7.91
Childcare attendance	Attendance in early non-formal childcare center for ages 0–4 years					
yes/no	Equals 1 if child attended childcare	0.82	0.39	0	1	17.79
in years	Number of years of childcare attendance	2.14	1.34	0	4	
in years^2	Number of years of childcare attendance squared	6.39	5.50	0	16	
Age	Difference between 2021 and birth year	6.39	.51	5	9	0.69
Gender	Equals 1 if child was male	.50	.50	0	1	13.07
Migration background	Migration background assessed on parent's and child's birth country					
Native	Equals 1 if child and both parents were born in Luxembourg	0.47	0.50	0	1	16.23
First generation	Equals 1 if child and both parents were born outside Luxembourg	0.15	0.35	0	1	
Second generation	Equals 1 if parents were born outside Luxembourg and child was born in Luxembourg	0.38	0.49	0	1	
Socioeconomic Status (HISEI)	Parent's highest occupational status defined by International Socio-Economic Index of Occupational Status (Ganzeboom, 2010)	51.50	15.83	16.25	69.90	17.05
Home language group	Groups based on the language that child speaks most frequently with parents					
MonoLI	Equals 1 if child speaks only Luxembourgish/German with parents	0.32	0.47	0	1	10.37
MultiLI	Equals 1 if child speaks Luxembourgish/German and at least one other language with parents	0.16	0.36	0	1	
NonLI	Equals 1 if child does not speak Luxembourgish/German with parents	0.52	0.50	0	1	

Note. Source = ÉpStan 2021, Missing % = percentage of the full sample missing information on this variable.

parents born outside the country) or second-generation (parents born outside the country) immigrants. The necessity of including both migration background and home language in the analyses is underlined by the high linguistic diversity within native families in Luxembourg, where 17% of native families do not speak the language of instruction at home. Socioeconomic status was operationalized by the highest parental occupational status as defined by the International Socio-Economic Index of Occupational Status (Ganzeboom, 2010). The resulting HISEI scores can range from 10 to 89, with high values indicating a high socioeconomic status. Information on sample composition can be found in Table 1.

Analytic approach

As students were clustered within schools and classes, we used three-level regressions to account for the lack of statistical independence and possibly skewed estimates and standard errors. In order to run estimations capable of three-level modeling, we omitted cases of missing data with a list-wise deletion approach (see Table 1 and Appendix for more information on missing data). Supplemental analyses of missing data in our sample show a slight underrepresentation of children with lower LLC. They also indicate that potential comprehension problems with the language of the questionnaire may explain some of the missing data (see Appendix). To be sure that the listwise deletion did not bias our results, we conducted robustness analyses with imputed data and cluster robust *SE's* (see Appendix). The results remained consistent in both direction and significance.

The null model with random intercepts at class and school level allowed us to estimate the outcome variability at each of the three levels: students, classes, and schools (Hox et al., 2017). The ICC coefficient based on the variance components of the null model indicated that out of the total variance in LLC, 18% was located at the school level and 6% at the class level, justifying clustered regressions.

We report six multilevel models to estimate the association between early childcare attendance and duration with LLC.

The first three models, 1a, 1b, and 1c, present the estimations of LLC with early childcare attendance (yes/no). Model 1a introduced early childcare attendance as the predictor. Model 1b, the covariate model, added five family background characteristics: age, gender, migration background, socioeconomic status, and home language group.[4] We then added a two-way interaction term of early childcare attendance with home language group in Model 1c, the moderation model. Model 1c examined whether the association between early childcare attendance and LLC varies across home language groups.

The last three models, 2a, 2b, and 2c, followed the same procedure. However, the key variables were now early childcare duration (number of years in childcare) and a quadratic term, allowing for a more detailed analysis of the association between early childcare and LLC. For Models 1c and 2c, subsequent post hoc tests for each home language group were conducted using pairwise comparisons of the estimated marginal means within and between home language groups. The results were noted as unstandardized coefficients and presented in margin plots for ease of interpretation. For all statistical tests, an alpha level of .05 was used. Alpha levels for the post-hoc tests were adjusted using the Tukey method. We report Cohen's d as an effect size for the post-hoc tests. Effect interpretation is based on Cohen (1988), where $|d| = .20$ indicates small effects, $|d| = .50$ medium effects, and $|d| = .80$ large effects.

Histogram, Q–Q plot, and a positive kurtosis value (3.37) indicated that the dependent variable, LLC, might deviate from a normal distribution toward a leptokurtic distribution. Skewness and kurtosis values, however, were within some commonly suggested cutoff criteria (Byrne, 2011, p. 99). Requirements of multilevel linear regressions were then examined. Visual inspections and Levene's test confirmed homoscedasticity at the student level. However, Shapiro–Wilk tests indicated non-normality of residuals at the student level and non-normality of the random intercept. As visual inspections showed near-normality and Shapiro–Wilk tests tend toward significance in large samples such as ours, normality was assumed.

The analyses were performed using R version 4.3.1 (R Core Team, 2024a) with the packages apaTables (Stanley, 2023), emmeans (Lenth, 2023), ggeffects (Lüdecke, 2018), haven (Wickham et al., 2023), lmerTest (Kuznetsova et al., 2017), lme4 (Bates et al., 2015), mfp2 (Kipruto et al., 2025), performance (Lüdecke et al., 2021), rmarkdown (Allaire et al., 2023), sjstats (Lüdecke, 2022), stats (R Core Team, 2024b), texreg (Leifeld, 2013), and tidyverse (Wickham et al., 2019). Prerequisite and additional analyses were performed with car (Fox & Weisberg, 2019), mice (Buuren & Groothuis-Oudshoorn, 2024), moments (Komsta & Novomestky, 2022), nlme (Pinheiro & Bates, 2023), psych (Revelle, 2023), rstatix (Kassambara, 2023), and sjPlot (Lüdecke, 2023).

Results

Table 1 shows that the great majority of children (82%) attended early childcare with an average duration of 2 years. The maximum duration of childcare attendance was 4 years. In addition, Table 2 shows that there are descriptive differences between the language groups in terms of childcare attendance and duration. NonLI and MultiLI students were more likely to attend early childcare and attend for more years than the MonoLI group. More information can be found in the correlation table (see Table 3).

The results of our estimations are presented in Table 4. When early childcare was included as the only predictor in the analysis, neither Model 1a (yes/no) nor Model 2a (number of years) showed significant associations with LLC. When family background information was added as covariates in Models 1b and 2b, the coefficients for early childcare turned significant and showed a positive association with LLC. In particular, children who attended early childcare were expected to score approximately 8 points higher in LLC ($b = 8.08$, $p < .05$) compared to those who did not. In the ÉpStan metric, this is a small, meaningful difference. In addition, Model 2b, with significant coefficients for early childcare duration ($b = 9.76$, $p < .01$) and the quadratic term of early childcare duration ($b = -2.02$, $p < .05$), indicates that there was an inverted U-shaped relationship between early childcare duration and LLC. For clarity and ease of interpretation, Figure 1 illustrates that the children with the highest LLC scores were those with an average duration of early childcare of 2 and 3 years. For example, a native six-year-old girl, with average socioeconomic status speaking the language of instruction at home reached an estimated 582 points after 2 years in childcare, which is 12 points higher than the score for 0 years in early childcare and 4 points higher than the score for 4 years.

The control variables were all significant, showed the expected signs, and aligned with abundant research. Younger children, boys, children with a migration background, NonLI, and MultiLI students, or students from socioeconomically disadvantaged families scored lower in LLC compared to older children, girls, native students, MonoLI students, or children from socioeconomically advantaged families.

It is worth noting that the coefficients for early childcare only became significant after including background variables, suggesting a suppressor effect. Including family background strengthened the predictive value of early childcare attendance, especially since multilingual children tended to spend

Table 2. Sample characteristics and ECEC attendance by home language group.

Home language group	Listening comprehension *M* (*SD*)	Childcare non-attenders %	Childcare duration of 1 year %	Childcare duration of 2 years %	Childcare duration of 3 years %	Childcare duration of 4 years %	Age *M* (*SD*)	Gender, male %	Native %	HISEI *M* (*SD*)
MonoLI	580.71 (88.92)	26.18	14.10	25.77	23.26	10.70	6.38 (.51)	52.35	93.27	54.75 (14.58)
MultiLI	511.91 (101.76)	15.15	12.12	20.88	32.32	19.53	6.35 (.50)	50.17	57.24	52.53 (15.32)
NonLI	474.22 (91.49)	13.85	11.59	23.83	30.03	20.71	6.40 (.50)	48.77	15.42	49.18 (16.33)

Note. Source = ÉpStan 2021. HISEI = Highest International Socio-Economic Index of Occupational Status (Ganzeboom, 2010).

Table 3. Correlations with confidence intervals between all variables included in the models.

Variable	1	2	3	4	5	6	7	8	9
1. Listening comprehension									
2. Childcare attendance yes (reference: no)	.00 [−.03, .03]								
3. Childcare attendance in years	−.04* [−.07, −.01]	.75** [.74, .76]							
4. HL group MultiLI (reference: MonoLI)	−.44** [−.46, −.41]	.14** [.11, .18]	.18** [.15, .21]						
5. HL group NonLI (reference: MonoLI)	−.39** [−.42, −.37]	.11** [.08, .14]	.14** [.11, .17]	.72** [.70, .73]					
6. 1st generation migration background (reference: Natives)	−.40** [−.42, −.37]	.09** [.06, .12]	.11** [.08, .14]	.64** [.62, .66]	.66** [.64, .67]				
7. 2nd generation migration background (reference: natives)	−.28** [−.31, −.26]	.10** [.07, .13]	.16** [.13, .19]	.48** [.45, .50]	.46** [.43, .48]	.74** [.73, .75]			
8. Socioeconomic status (HISEI)	.31** [.28, .33]	.06** [.03, .10]	.01 [−.02, .04]	−.14** [−.17, −.11]	−.14** [−.17, −.11]	−.12** [−.15, −.09]	−.15** [−.18, −.12]		
9.Male gender (reference: female)	−.06** [−.09, −.03]	.01 [−.03, .04]	.00 [−.03, .04]	−.03 [−.06, .00]	−.03 [−.06, .00]	−.03 [−.06, .01]	−.03* [−.06, −.00]	−.00 [−.04, .03]	
10. Age	.00 [−.03, .04]	−.03 [−.06, .00]	−.01 [−.04, .02]	.00 [−.03, .03]	.02 [−.01, .05]	.02 [−.01, .05]	−.02 [−.06, .01]	−.09** [−.12, −.06]	.03* [.00, .06]

Note. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). ***$p < .001$; **$p < .01$; *$p < .05$.

Table 4. Overview of results and fit of all six models predicting Luxembourgish listening comprehension.

	Attendance (yes/no)			Attendance (in years)		
	Model 1a	Model 1b	Model 1c	Model 2a	Model 2b	Model 2c
(Intercept)	525.28 ***	446.35 ***	461.50 ***	519.17 ***	452.05 ***	457.50 ***
	(8.20)	(19.20)	(20.31)	(4.97)	(18.38)	(18.45)
Childcare attendance yes (reference no)	−3.64	8.08 *	−0.82			
	(3.94)	(3.51)	(5.30)			
in years				5.93	9.76 **	7.39 *
				(3.75)	(3.32)	(3.42)
in years^2				−2.08 *	−2.02 *	−2.50 **
				(0.92)	(0.81)	(0.82)
Age		7.51 **	7.63 **		7.74 **	8.01 **
		(2.63)	(2.63)		(2.63)	(2.63)
Gender (reference female)		−15.26 ***	−15.32 ***		−15.23 ***	−15.23 ***
		(2.63)	(2.63)		(2.63)	(2.62)
Migration (reference Native)						
First generation		−33.74 ***	−33.23 ***		−33.55 ***	−32.36 ***
		(4.87)	(4.87)		(4.89)	(4.90)
Second generation		−25.43 ***	−25.46 ***		−25.40 ***	−25.35 ***
		(3.91)	(3.91)		(3.91)	(3.91)
Socioeconomic status		1.37 ***	1.36 ***		1.36 ***	1.35 ***
		(0.09)	(0.09)		(0.09)	(0.09)
Home language (reference MonoLI)						
MultiLI		−45.54 ***	−52.42 ***		−45.60 ***	−54.22 ***
		(4.38)	(20.06)		(4.39)	(7.93)
NonLI		−64.06 ***	−99.42 ***		−64.27 ***	−78.86 ***
		(4.23)	(14.21)		(4.25)	(6.34)
Interactions						
Attendance yes * MultiLI			4.22			
			(10.72)			
Attendance yes * NonLI			19.47 **			
			(7.49)			
Years * MultiLI						4.63
						(3.08)
Years * NonLI						7.05 **
						(2.27)
AIC	45,547.59	44,548.46	44,545.42	45,541.41	44,546.16	44,540.55
BIC	45,578.82	44,623.42	44,632.86	45,578.89	44,627.36	44,634.25
Log Likelihood	−22,768.80	−22,262.23	−22,258.71	−22,764.71	−22,260.08	−22,255.28
Class level variance	628.24	643.08	633.24	633.67	645.53	638.12
School level variance	1,846.34	797.45	791.30	1,800.58	787.98	777.09
Residual variance	8,029.95	6,194.19	6,187.18	8,015.92	6,187.64	6,176.20

Note. Unstandardized coefficients, SE reported in brackets, $N_{students} = 3{,}813$, $N_{classes} = 410$, $N_{schools} = 166$; ***$p < .001$; **$p < .01$; *$p < .05$.

more time in care (see Table 3). Once background was accounted for, the unique role of childcare became clearer. Concerns about multicollinearity between family background and early childcare variables were mitigated after additional analyses showed variance inflation factors (VIF) below two for the predictors.

Exploring the interplay of early childcare and home language in more depth, Models 1c and 2c integrated the interaction of early childcare with home language. Both models revealed a significantly better model fit[5] based on deviance testing and AIC than the models without moderation terms and thus represent the final models from which our research questions are addressed, underlining the importance of considering interaction effects.

In Model 1c, the interaction term between the home language group and early childcare attendance was significant, i.e., home language significantly moderated the relationship between childcare

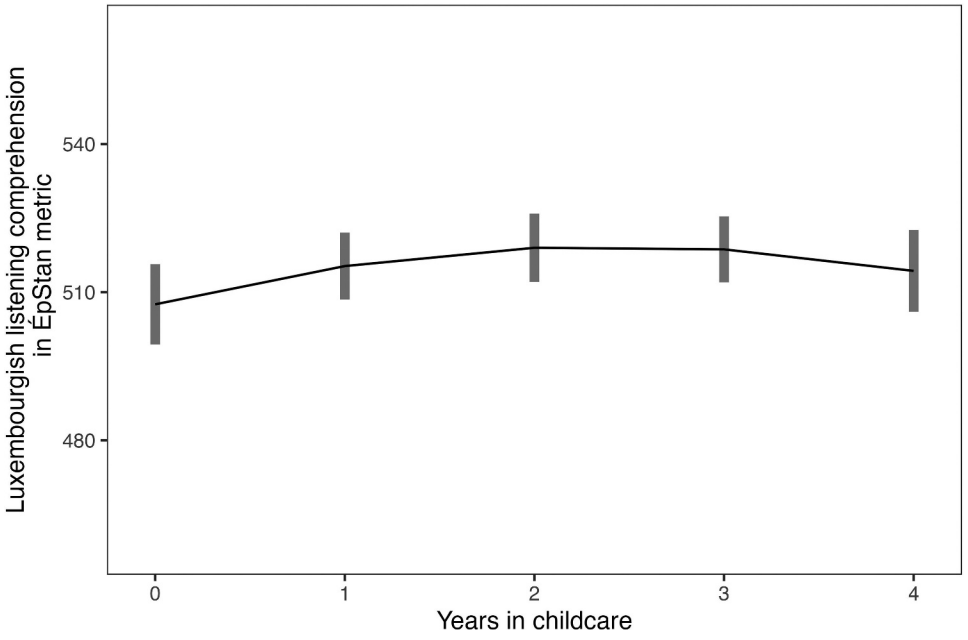

Figure 1. Margin plot of the nonlinear relationship between childcare duration and listening comprehension. *Note*. Source = ÉpStan 2021. Based on Model 2b. Graph shows the association between childcare duration in years and listening comprehension. Error bars show 95% confidence intervals.

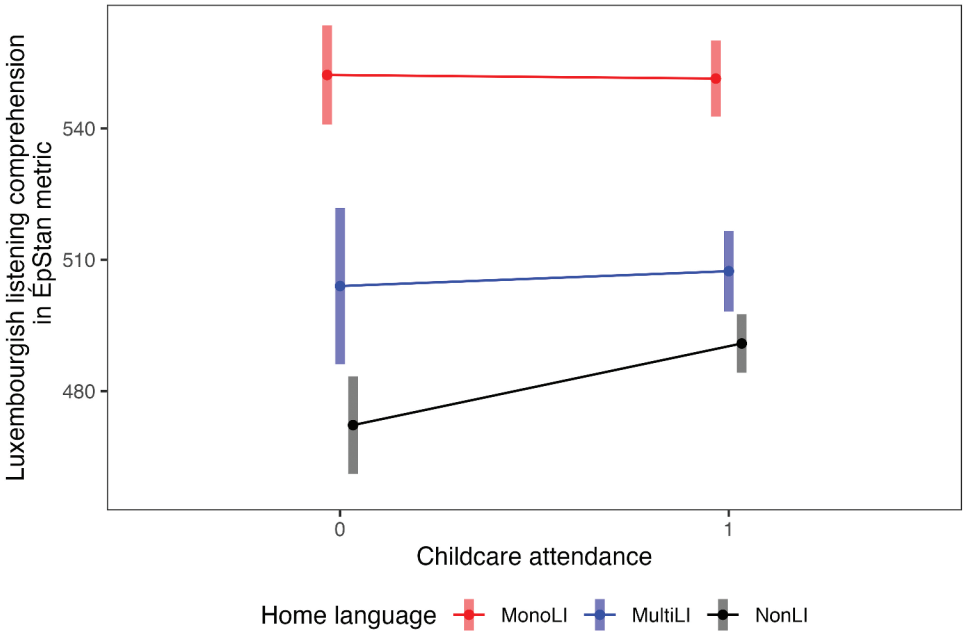

Figure 2. Margin plot of the two-way interaction between childcare attendance and home language group on listening comprehension. *Note*. Source = ÉpStan 2021. Based on Model 1c. Graph shows the association between childcare attendance and listening comprehension, separated by home language group. Error bars show 95% confidence intervals.

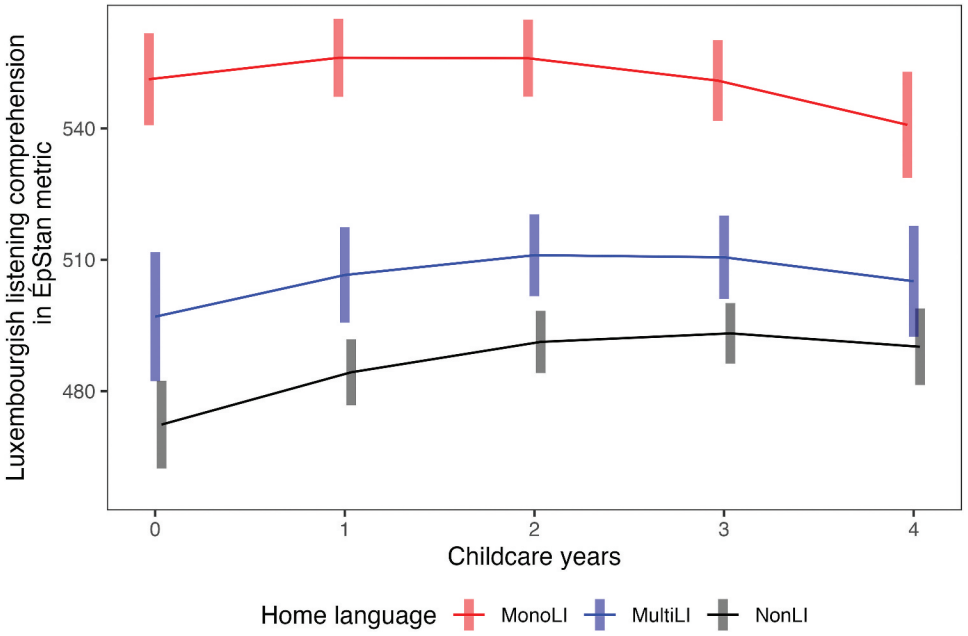

Figure 3. Margin plot of the two-way interaction between childcare duration and home language group on listening comprehension. *Note*. Source = ÉpStan 2021. Based on Model 2c. Graph shows the (nonlinear) association between childcare duration in years and listening comprehension, separated by home language group. Error bars show 95% confidence intervals.

attendance and LLC ($b = 19.47$, $p < .01$). A closer look at the moderation shows that the previous positive general effect of early childcare on LLC was driven by one particular group: For NonLI students, attending childcare was associated with significantly higher LLC scores. Their estimated mean ÉpStan scores differed by 18.64 ($p < .01$) with a Cohen's d of −.24, indicating a small effect size (more information on post-hoc tests in Table A2 in the Appendix). However, for MonoLI and MultiLI students, childcare attendance did not result in significant differences in LLC scores (contrast = .83 to −3.39, $p > .05$). Marginal effects are plotted in Figure 2 and visualize how the gap in LLC was slightly reduced when NonLI children attended early childcare before the age of four.

In Model 2c, home language also significantly moderated the relationship between childcare duration and LLC ($b = 7.05$, $p < .01$). Similar to Model 2b, both the linear and quadratic duration terms remained significant. Marginal effects are shown in Figure 3 for ease of interpretation. The plot descriptively shows that the highest LLC scores are found at a childcare duration of 1 to 2 years for MonoLI students, 2 to 3 years for MultiLI students, and 3 years for NonLI students. Post-hoc tests (see Table A2 in the Appendix) showed that LLC scores of NonLI children were significantly higher when children had attended childcare for 1 to 3 years in comparison to not attending or attending for 1 year (small effects with $d = -.09$ to $-.27$). For the MonoLI group, LLC scores were significantly higher when they had attended 2 to 3 years instead of 4 years of childcare (small effect with $d = .13$ to .19). The findings from Models 1c and 2c demonstrate that the association between early childcare and LLC significantly differed for NonLI children compared to MonoLI children. The difference was evidenced by the significant interaction term and the distinct slopes for NonLI children compared to MonoLI children: In Figure 2, NonLI children's scores showed an increase while MonoLI children's scores remained the same. The pattern is further confirmed by significant post-hoc tests, where the estimated difference of 80 points on the ÉpStan scale between MonoLI and NonLI groups *not* attending childcare is reduced to an estimated difference of 60.5 points between both groups *when* attending childcare (see Table A2 in the Appendix). In Figure 3, the NonLI children's curve revealed a peak at 3 years, while the MonoLI children's curve peaked at 1 to 2 years. The two curves then converge, the longer the children

attend childcare, as confirmed by significant post-hoc tests showing shrinking LLC score differences of 71.80 after 1 year, 64.80 after 2 years, 57.70 after 3 years, and 50.70 after 4 years of childcare attendance (see Table A2 in the Appendix).

A notable similarity between MultiLI and NonLI children became apparent from Figure 3, where both curves for MultiLI and NonLI children showed a similar shape, being steeper on the left-hand side until the third year of childcare attendance. This similarity did not emerge in the attendance model. Evidently, the duration of early childcare mattered with regard to LLC. However, while the coefficient and standard error sizes of the interaction terms supported the notion that both groups, MultiLI, and NonLI, were similar compared to MonoLI (MultiLI: $b = 4.63$, $SE = 3.08$; NonLI: $b = 7.05$, $SE = 2.27$), the coefficient of MultiLI did not reach the significance level of $p < .05$, nor did LLC scores in the post-hoc tests differ significantly by duration of childcare for the MultiLI group (see Table A2 in the Appendix).

To sum up, the results for Models 1c and 2c indicate that the association between early childcare and LLC significantly differed for children who do not speak the language of instruction at home compared to the monolingual Luxembourgish/German children. Specifically, 1 to 3 years of childcare attendance seemed to be beneficial for these children over not attending childcare.

Discussion

Summary

This study aimed to investigate the relationship between the attendance and duration of early childcare and later listening comprehension in the language of instruction among children from different linguistic backgrounds with varying levels of using the language of instruction at home. Our multilevel analyses using large-scale monitoring data indicated that the relationships of LLC in first grade with previous childcare attendance and its duration depended on the children's home language group. Specifically, while there were positive associations between listening comprehension and childcare attendance and duration for children not speaking the language of instruction at home, this association was not observed in children speaking the language of instruction mono- or multilingually at home. This partially confirms our hypothesis for Research Question 1 and fully confirms the moderation hypothesis of Research Question 2. As expected, we found an inverted U-shaped relationship between years of childcare and listening comprehension. We now discuss the results in more detail.

The positive effect of early childcare for children in the disadvantaged language group is consistent with most literature (DeAngelis et al., 2020; Loeb et al., 2007) and might be explained by several factors. Starting with the language of instruction early in life might be beneficial because language learning can happen more easily in the early years (Bruer, 2001; Friedmann & Rusou, 2015). In addition, an early start in ECEC often means the amount of time children spend engaged in literacy- and language-promoting activities increases. This provides them with consistent language models in the language of instruction and creates frequent opportunities for meaningful communication in that language (time-on-task hypothesis; see Godwin et al., 2021; Hoff, 2006). Additionally, it might be that the multilingual education environment in childcare fits well for some children in this group. The inclusion of multiple home languages in early childcare settings may help children feel welcomed and valued, while also enabling them to build on their home language skills (Bialystok, 2018). For example, attendance in bilingual ECEC in other countries has not been shown to impede the development of proficiency in the majority language (Bialystok, 2018; Thieme et al., 2022). Additionally, the level of Luxembourgish used in childcare may be well adapted to their linguistic needs, supporting their acquisition of the language of instruction.

In contrast, children that already speak Luxembourgish at home do not further benefit from childcare attendance in their LLC. This raises the question of whether using the language of instruction at home may have already brought children's language skills to a level at which time in early

childcare no longer yields significant additional gains. Additionally, the multilingual environment and the language level offered in childcare centers may be better tailored to the needs of children who do not speak Luxembourgish at home. As a result, Luxembourgish-speaking children might encounter less challenging language input in childcare settings compared to what they experience at home within their families (Larson et al., 2020).

Duration analyses revealed a slight curvilinear trend of years in childcare, which in our study was correlated with but could not be directly translated into age of entry. Considering the possibility that the children in our sample attended the first optional preschool year (ages 3 to 4 years) in public schools instead of spending a fourth year in childcare, our results could reflect either the benefits of a later start, e.g. after the first year of life, or the advantages of an earlier transition out of childcare, such as beginning preschool at age 3. On the one hand, a substantial body of literature cautions against starting non-parental care too early (Fort et al., 2016; Kottelenberg & Lehrer, 2014), particularly during the first year of life. During this period, children are not yet able to express their needs verbally (Im & Vanderweele, 2018) and require highly responsive caregiving, the consistent presence of a warm and sensitive caregiver, and a safe, secure environment (Bowlby, 2007). On the other hand, Li et al. (2020) and Soliday Hong et al. (2023) studies indicate that early starting ages were connected to greater positive childcare effects, while a longer duration was connected to smaller benefits of childcare. Therefore, our results may instead indicate that children have reached the maximum of benefits for Luxembourgish skills after 1 to 3 years in childcare (Li et al., 2020; Wasik & Snell, 2019) and may benefit more strongly from a transition to preschool ("précoce") at age 3 and the experience of formal ECEC with explicit promotion of the Luxembourgish language and other school readiness skills.

More specifically, we found that the curvilinear trend with a descriptive peak at 1 to 3 years depended on the home language group. Thus, the "optimal" duration of childcare varied with the child's background. That is, children with the least usage of the language of instruction (those not speaking the language with their parents) benefited the most from a longer duration of 2 or 3 years. Children who speak the language of instruction, either mono- or multilingually at home, had their peak in their LLC at marginally shorter durations of early childcare (around 2 years). These findings align with studies showing inverted U-shaped effects of childcare duration (Loeb et al., 2007) and build on Kohl et al.'s (2019) insight that children with the least exposure to the language of instruction at home are more likely to benefit from extended childcare. For these children, ECEC structures can offer a variety of learning and interaction opportunities, providing age-appropriate educational enrichment as well as language models and more communicative opportunities in the language of instruction than they may encounter at home (Council of the European Union, 2019; Kagitcibasi et al., 2009). For children that speak the language of instruction at home, more years in childcare were not associated with higher LLC. Instead, post-hoc tests for the MonoLI group showed lower LLC in the case of 4 years in childcare in comparison to 2 or 3 years in childcare (Table A2 in Appendix). As described above, this may be due to a need for a more challenging language level in ECEC which might be more accessible in the subsequent ECEC setting, i.e., early voluntary preschool at age three (Li et al., 2020).

Moreover, our results highlight that early childcare does not fully close the performance gap between children from different linguistic backgrounds (see Table A2 in the Appendix). Even after a long duration of early childcare attendance, children who speak the language of instruction at home still performed better. On the one hand, this may be due to the sizable head start of monolingual children and the importance of the home language in general (Paradis, 2011; Schulz & Grimm, 2019). On the other hand, children who do not speak the language of instruction at home might only experience the language of instruction in the ECEC context (Paradis, 2011) where the quality of the language environment may be constrained to directive speech rather than including complex language stimulation (Atkins-Burnett et al., 2011; Sawyer et al., 2018). Thus, with a more limited input, full proficiency in the language of instruction may not be achievable within a time frame comparable to that of monolingual children. Alternatively, the high number of languages included in the multilingual Luxembourgish childcare services beyond the instructional and home language may make it challenging to provide each child with focused opportunities to engage with only their home and school

languages and lead to less dedicated time-on-task (Godwin et al., 2021) with the assessed language Luxembourgish.

Limitations and outlook

As we report in Table 2, early childcare attendance was associated with family background. For example, children who do not speak the language of instruction at home were more likely to attend early childcare and attend for more years than their peers. Not only attendance and duration of childcare, but also the intensity of childcare attendance in hours might vary across families and influence the effects of attending ECEC (Yazejian et al., 2015). We controlled for differences in the attendance patterns that stem from family background characteristics (i.e., home language, socio-economic status, migration background) by including these covariates in our models. However, the role of attendance intensity will need to be considered in future studies. Moreover, family background factors, such as migration and home language are intercorrelated. Research has indicated the potential for a complex interplay between these two variables, with implications for early achievement (Yazejian et al., 2015). Further research is required to disentangle their effects with regard to ECEC.

The languages spoken in early childcare and the quality of the language environment were not taken into account in this study. First, we turn to the aspect of which language is spoken: while in most countries, the language of instruction and therefore the lingua franca for children of different backgrounds is clear (Tracy, 2009), this is less straightforward in multilingual Luxembourg. Although, since the 2017 reform, childcare centers have been required to promote Luxembourgish and French (MENJE et al., 2021), many also offer additional languages, such as Portuguese or English, the most prominent languages in Luxembourg after the three official ones. Additionally, caregivers and teachers are instructed to valorize the home languages of all children. Given this heterogeneity and flexibility in early childcare languages, the timing of language of instruction input may vary significantly across children and early childcare centers, which may in turn influence the effects on performance (Votruba-Drzal et al., 2015). Future research should therefore consider the languages spoken in ECEC, including the communicative settings and pre-literacy activities, and investigate the relationship of the language input in ECEC with individual language development and later academic performance.

Second, the quality of care and language stimulation have also been shown to play a critical role in supporting the long-term development of children's language skills (Sylva et al., 2011; van Huizen & Plantenga, 2018). In Luxembourg, systematic data on the quality of childcare and the language environment are currently missing, as the ECEC landscape, providers, and regulations are quite heterogeneous and partly private. Therefore, we were not able to include quality of care and language environment in our study. However, policy efforts to ensure high quality in childcare have intensified in recent years, and the systematic collection of data on childcare centers is still in the process of being further developed (Meisch & Hahn, 2025; OECD, 2022). We highly recommend this systematic evaluation and monitoring of ECEC quality in the field to identify measures that could further improve childcare quality in Luxembourg.

Implications

Based on the discovered beneficial childcare effects among children with little contact to the language of instruction at home, there is the question of whether raising attendance and the duration of early childcare in the multilingual group might help provide more equal starting conditions in Luxembourg. While disadvantaged groups are usually underrepresented in ECEC (Lazzari & Vandenbroeck, 2012), Luxembourg's attendance rates show a different picture (see Table 2). A third of children speaking other languages than the language of instruction at home already attended childcare for 3 years, the "optimum" for that group. However, another fourth of this group attended early childcare for less than 2 years. Informing the respective parents about the potential language benefits of a slightly longer

duration in early childcare could help to further boost the starting opportunities of multilingual children in first grade.

Secondly, while more research is needed to make sure that the discovered curvilinear duration effect indeed stems from the benefits of ending childcare early and attending voluntary preschool ("précoce") at age three, the majority of evidence points in this direction (Hornung et al., 2023; Li et al., 2020; Soliday Hong et al., 2023). Attendance in "précoce" is already quite high (76% in 2021, see OEJQS, 2024). However, it is less used by those that would benefit the most (Hornung et al., 2023). To ensure that all children, especially disadvantaged children, can access the précoce year, it is essential to further investigate the reasons for nonattendance and to prioritize the removal of known barriers, such as inflexible hours, by introducing full-day preschools.

Thirdly, our less beneficial findings for the monolingual home language group indicate that the language level in childcare may not be enriching or challenging enough for children already speaking the language at home to further foster their listening comprehension (Larson et al., 2020), while in other countries, children exhibited higher language skills when attending ECEC independent of their home language (Yazejian et al., 2015; Zambrana et al., 2016). Policy efforts to not only monitor but also improve the language environments in childcare to benefit all children are thus essential. One important step in this direction could be the promotion of higher qualification standards for early childcare staff. Currently, qualification requirements in Luxembourg's early childcare sector are relatively low compared to other OECD countries (OECD, 2022). Additionally, it should be noted that the monolingual group may profit from early childcare in other domains, such as school readiness skills, self-regulation, or social skills (Fukkink et al., 2024; Melo et al., 2022).

Lastly, compared to the effect sizes of the family background variables, the ECEC associations are considerably smaller and gaps are not closed (Hornung et al., 2023). A greater impact of early childcare on language of instruction skills might be possible with increased process quality in ECEC and enriched language environments (Ulferts et al., 2019; van Huizen & Plantenga, 2018). With challenging times ahead, a high-quality provision of ECEC for all children is crucial in Luxembourg and other countries. Fortunately, policy and monitoring efforts to ensure high quality in childcare have been gaining momentum with an increase in quality inspections since 2023. As recommended by OECD, broadening the available information on process quality by also introducing a systematic monitoring of interactions between staff and children could help "to identify gaps that need to be addressed and further guide policy development" (OECD, 2022, p. 19).

Conclusion

Using large-scale data from Luxembourg's multilingual student population, this study indicates that the associations of early childcare attendance before the age of 4 years with first graders' listening comprehension in the language of instruction depended on the children's home language group. Multilingual students – those not speaking the language of instruction at home – were the only group to benefit significantly from attendance and more years in early childcare in a multilingual context. The moderated and curvilinear trend in childcare duration suggests that the optimal length of attendance varied across different home language groups. As receptive language skills, such as listening comprehension, provide the foundation for literacy acquisition and learning in all other school subjects, ECEC plays a vital role in potentially providing multilingual children with better opportunities to succeed when they start school.

Notes

1. In the publicly funded childcare sector, language proficiency in Luxembourgish and French has been required since the implementation of the plurilingual education programme in 2017. In the commercial childcare sector, proficiency in one official language is sufficient (De Moll et al., 2024).

2. While the early languages of instruction, Luxembourgish and German, are crucial for the academic trajectory and success, they do not serve as the dominant societal languages in the country as certain professions and administrative work are carried out in French. Thus, in this study, we refer to Luxembourgish and German as the languages of instruction rather than the majority languages.
3. Luxembourgish originated as a German Moselle-Franconian dialect, so the two languages are linguistically close. Only a small group of children (8%) spoke German at home, and they scored similarly to the Luxembourgish group in the dependent variable. Therefore, Luxembourgish and German were grouped together in our home language groups.
4. We also tested exploratively one by one whether one of the coefficients of the full model had a random slope. All of these models produced warnings because of singular fit or non-convergence. Thus, we excluded random slopes in this study.
5. The BIC of the moderation models was slightly higher than for Models 1b and 2b as BIC penalizes model complexity more heavily (Field, 2009). Because both AIC and deviance testing point toward better fit, we choose Models c as the final models.

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Data availability statement

ÉpStan data is stored on LUCET servers. The data are not publicly available due to their containing information that could compromise the privacy of the participating students. Anonymized data supporting the findings of this study can be requested via https://www.bridgebuilder.lu/.

Disclosure statement

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