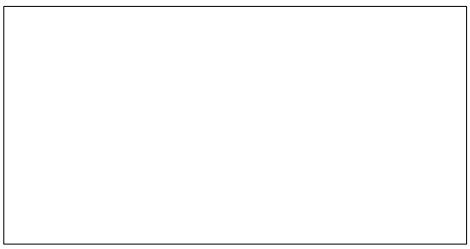

Scientific Studies of Reading

ISSN: 1088-8438 (Print) 1532-799X (Online) Journal homepage: www.tandfonline.com/journals/hssr20

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To cite this article: Pascale M. J. Engel de Abreu, Carolina Nikaedo, Ariana Loff, Margaret J. Snowling, Charles Hulme & Silke Fricke (2025) Assessing the Impact of a Heritage Language Intervention in Preschool: A Controlled Trial with Dual Language Learners from Immigrant Families, Scientific Studies of Reading, 29:6, 521-543, DOI: 10.1080/10888438.2025.2554672

To link to this article: https://doi.org/10.1080/10888438.2025.2554672

SCIENTIFIC STUDIES OF READING
2025, VOL. 29, NO. 6, 521–543
https://doi.org/10.1080/10888438.2025.2554672

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Assessing the Impact of a Heritage Language Intervention in Preschool: A Controlled Trial with Dual Language Learners from Immigrant Families

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ABSTRACT

Purpose: This exploratory randomized controlled trial evaluated the efficacy of a heritage language intervention for dual language learners (DLLs) with a migration background. The primary objective was to assess the intervention´s impact on heritage language development; a secondary objective was to explore its effects on the languages of instruction at school.

Method: The sample included 186 DLLs (48% girls) from Portuguese-speaking immigrant families in Luxembourg, where Luxembourgish is the societal and preschool language, and Luxembourgish and German serve as languages of instruction in the early elementary school years. With a mean age of 55 months at the start of the trial, participants were randomly assigned to an oral language intervention in Portuguese or an active control intervention. Assessments in the heritage language Portuguese and instruction languages, Luxembourgish and German, were conducted immediately post-intervention and nine months later.

Results: Immediate post-intervention assessments showed significant gains in Portuguese language proficiency – including vocabulary, narrative skills, phonemic awareness, and letter-sound knowledge – for the heritage language intervention group compared to controls. Gains in expressive vocabulary and phonemic awareness were sustained at follow-up in elementary school. Improvements were also observed in Luxembourgish receptive vocabulary and phonemic awareness. No group differences were found in German oral language and reading assessments.

Conclusion: The findings highlight the efficacy of a heritage language intervention in enhancing heritage language skills and supporting aspects of development in the language of instruction. These results suggest that supporting heritage language development in preschool can promote multilingual growth without compromising school language acquisition.

Introduction

Children who enter school with limited language skills face an increased risk of academic underachievement (Conti-Ramsden et al., 2009; Hoff, 2013; Snowling et al., 2001). This risk is particularly pronounced for dual-language learners (DLLs) from immigrant families, whose heritage language – spoken at home and tied to their cultural identity – differs from the language of instruction at school.

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/10888438.2025.2554672

These children face unique challenges at school, as they must simultaneously acquire a new language, engage with academic content in that language, and continue developing proficiency in their heritage language (Bialystok et al., 2010; Gunnerud et al., 2018; Organisation for Economic Co-operation and Development, 2018). As a result, DLLs from migrant backgrounds are at heightened risk for reading difficulties and other academic challenges and are often overrepresented in special education programs (Artiles et al., 2005; Cirino et al., 2009; Rueda & Windmueller, 2006). Addressing these disparities and ensuring equitable learning opportunities for DLLs, while also fostering cultural and linguistic diversity in schools, is a global priority (UNESCO, 2025; United Nations, 2015). In response, various interventions and educational approaches have been developed to support DLLs in the language of instruction, with varying degrees of success (Rogde et al., 2016; Vadasy et al., 2015; West et al., 2021).

A disadvantage of interventions for DLLs that focus solely on the language of instruction is the risk of alienating children from their cultural and language heritage (Mu, 2015), thereby depriving them of the socio-emotional and cognitive benefits of a sound heritage language and identity (Adesope et al., 2010; Bialystok & Craik, 2022; García & Kleifgen, 2018; Ticheloven & Blom, 2025). Another unintended consequence is the potential for subtractive bilingualism, where the instructional language develops at the expense of the heritage language, leading to its gradual underdevelopment or loss and limiting the child's linguistic and cultural resources (Karayayla & Schmid, 2018; Köpke & Genevska-Hanke, 2018; Montrul, 2008). Limited heritage language proficiency can also create family communication barriers, weakening family-child relationships and bonds (Leyendecker et al., 2018; Lim et al., 2019; Wong Fillmore, 1991). These challenges can negatively impact children´s well-being, identity, and sense of belonging both within the family and the broader community (Kilpi-Jakonen & Kwon, 2023; Mu, 2015; Ticheloven & Blom, 2025).

While supporting DLLs in acquiring the instructional language is crucial for academic success (West et al., 2021), preserving and enriching their heritage language is equally important. Research indicates that children who actively engage with their heritage language are more likely to experience academic success, develop stronger socio-emotional skills, build resilience, enhance emotional well-being, and foster increased parental involvement (Ball, 2011; Farndale et al., 2016; Rolstad et al., 2005; Ticheloven & Blom, 2025). Based on this evidence, scholars argue that early language interventions should integrate heritage language into a comprehensive support approach for DLLs (Kohnert et al., 2005; Lim et al., 2019). Aligning with this perspective, recent calls advocate for heritage language instruction as a key educational strategy, with the potential to improve learning outcomes, reduce dropout rates, strengthening social cohesion and promote inclusion, and peaceful coexistence (UNESCO, 2025).

Despite growing recognition of the importance of heritage languages for educational success, their integration into formal education remains limited (Reljić et al., 2015; UNESCO, 2025). Indeed, the presence of a large variety of heritage languages in classrooms is often cited as a reason not to aim for heritage language support in mainstream school settings. This linguistic diversity is frequently viewed as a barrier to providing targeted heritage language support, leading schools to prioritize the dominant or national language over additive bilingual approaches (European Commission: Directorate-General for Education, Youth, Sport and Culture, ECORYS et al., 2017). However, many researchers and educators advocate for more inclusive policies despite the challenges. Substantial evidence supports heritage language instruction albeit mostly based on research that originates from the United States and focuses on English-language learners (Farver et al. 2009; Rolstad et al. 2005; Valentino and Reardon 2015). Arguably the European context presents different challenges (Reljić et al., 2015; Stanat & Christensen, 2006): of 40 countries in Europe, 34 have policies supporting migrant students in the instructional language, yet only nine provide structured heritage language support. Barriers to implementation include a lack of evidence-based programs and ongoing ideological and political debates on minority languages in education (European Commission et al., 2017).

This debate is shaped by two competing theoretical perspectives. The language transfer hypothesis posits that maintaining and developing a child's heritage language fosters an inclusive school

environment and enhances proficiency in the instructional language (Cha & Goldenberg, 2015; Cummins, 2008). Proponents argue bilingualism strengthens cognitive flexibility and facilitates linguistic transfer, yielding long-term academic and cognitive benefits (Adescope et al Adesope et al., 2010; Engel de Abreu et al., 2012; Genesee et al., 2006; MacSwan & Rolstad, 2005). Conversely, the "time-on-task" hypothesis argues that maximizing DLL's exposure to the instructional language accelerates acquisition, while instructional time spent on heritage languages may detract from proficiency in the language of instruction and hinder academic performance (Rossell & Baker, 1996). This perspective continues to shape European policies, where monolingual policies and full immersion remain the dominant approach for DLLs (European Commission: Directorate-General for Education, Youth, Sport and Culture, ECORYS et al., 2017). For example, a survey of 775 Flemish teachers in Belgium found that 72% believed speaking a heritage language at school would hinder students' ability to learn the instructional language sufficiently, and 77% thought heritage languages should not be spoken at school. Additionally, 29% felt that it was in the best interest of students to be punished for speaking a heritage language at school (Pulinx et al., 2017).

With such debates as a backdrop, here we evaluate the potential for encouraging additive bilingualism in the multilingual context of Luxembourg. Several studies now support the integration of heritage language instruction into mainstream education (Cummins, 2008; Farver et al., 2009; Genesee et al., 2006; MacSwan et al., 2017) but methodological limitations, including reliance on non-experimental designs and a predominant focus on instructional language proficiency, prevent strong conclusions. Findings may also be context-dependent, influenced by specific educational settings and language combinations, such as Spanish-English programs in the United States or French immersion in Canada.

The present study

This study reports a randomized controlled trial (RCT) evaluating the efficacy of a preschool oral language intervention in the heritage language for Portuguese-speaking children from immigrant families in Luxembourg. In this context, Luxembourgish is the societal and preschool instructional language, while reading instruction in elementary school is in German. The study´s primary aim was to assess the intervention´s impact on the heritage language, with secondary aims exploring effects on Luxembourgish and German.

Luxembourg, a small and linguistic diverse European country, has a significant immigrant student population, with 44% of elementary school students being, non-Luxembourgish nationals (Ministère de l'Éducation nationale, de l'Enfance et de la Jeunesse, 2023). The country has three official languages – Luxembourgish, French, and German. Luxembourgish serves as the national language and primary spoken language (Fehlen et al., 2021). Preschool instruction, compulsory from age four, is conducted in Luxembourgish and play-based, while formal literacy instruction begins in elementary school (Year 1) and is delivered in German.

Linguistic heterogeneity among students is particularly pronounced, with approximately 68% not speaking Luxembourgish at home (Ministère de l'Éducation nationale, de l'Enfance et de la Jeunesse, 2023). Portuguese is the most common home language, spoken by approximately 27% of students (Lenz & Heinz, 2018). This demographic pattern stems from labor migration in the 1960s, when a bilateral agreement facilitated Portuguese workers' recruitment for Luxembourg's steel and construction industries. Although integration has progressed across generations, many Portuguese migrants remain in manual labor sectors, contributing to socio-economic disparities in educational attainment (Tourbeaux, 2012).

Portuguese-speaking students are at increased risk of academic underachievement in Luxembourg: National data indicates that 72% fail to meet expected reading proficiency by age nine and are disproportionately placed in lower secondary education tracks (LUCET, 2025). Research consistently shows that, upon school entry, Portuguese-speaking children have lower proficiency in both the school and heritage language compared to their peers (Engel de Abreu et al., 2012, 2013). Longitudinal studies

have shown that, while they acquire the instructional language during preschool, their progress is slower than that of their peers, and development of the Portuguese heritage language slows significantly (Nikaedo et al., 2024). As a result, they may experience compounded linguistic, cognitive, and socio-emotional disadvantages, which could have lasting effects on their academic and personal development.

The aim of this trial was to develop and evaluate a theoretically grounded oral language (OL) intervention designed to support Portuguese-speaking children from immigrant families in maintaining and developing their heritage language whilst continuing their education in the societal language. Unlike many bilingual and heritage language programs that focus on using the heritage language to facilitate the transition into the instructional language (Farver et al., 2009; Valentino & Reardon, 2015), our intervention did not explicitly target language transfer, rather the broad aim was to avoid subtractive bilingualism. Thus, the primary objective was to prevent heritage language loss, which has been linked to significant educational, socio-emotional, and identity challenges in children from migrant backgrounds.

The study draws on evidence of the effectiveness of the Nuffield Early Language Intervention (NELI) program (Fricke et al., 2017). This UK-based early education intervention has been tested in several robust trials and proven effective in supporting children´s oral language skills in English (Snowling & Hulme, 2025). The intervention includes group and individual sessions conducted over 10-week blocks, focusing on active listening and speaking, vocabulary, and narrative skills, with preliteracy activities included in the final block. Delivered by trained and supported staff, the intervention has been shown to lead to significant improvements in oral language, narrative skills, and preliteracy, typically maintained at a six-month follow-up.

Here we report a controlled trial of an adapted 30-week version of the NELI intervention (Fricke et al., 2013), aimed at enhancing Portuguese oral language and preliteracy skills. Rather than a direct translation, the Portuguese version was contextualized to take account of the linguistic, educational, and socio-cultural environment in which it would be implemented. Key changes included the introduction of phonological awareness from the beginning of the intervention. The rationale for this was that, whereas preliteracy skills are systematically introduced in preschool in the UK (requiring less focus in the intervention), these skills are typically introduced later in Luxembourg's educational system. Their inclusion throughout the current program was intended to foster a solid foundation for reading development. Work on narrative skills was reduced to accommodate this change in the sessions. A further change, compared to the UK program, was the shift from a mix of group and individual sessions to group sessions only, delivered four times a week in 30-minute "pull-out" sessions. This change was made to ensure long-term scalability, recognizing the challenges related to one-to-one heritage language support and sustainability in mainstream schools.

The trial included an active control group of children who participated in an early mathematical (EM) skills program. While a business-as-usual control group is often used in educational trials (Fricke et al., 2013; West et al., 2021), the active-control intervention was intended to control for "Hawthorne" effects, where changes in behavior could result from additional attention participants received and was ethically justified. The EM intervention, delivered in the preschool instructional language Luxembourgish, targeted visuospatial processing, non-symbolic numerical processing, and symbolic numerical processing.

Our first hypothesis predicted that the oral language intervention (OL) would bring about improvements in Portuguese language skills when compared to the active control group. We anticipated effects not only on the skills directly taught by the OL intervention but also on broader language domains in Portuguese that were not explicitly taught.

Our second hypothesis posited that, by supporting heritage language development through a pull-out program in a public preschool setting, the OL intervention would promote an additive form of bilingualism. Specifically, we expected the heritage language intervention to enhance proficiency in Portuguese without disrupting or hindering the development of the instructional languages, Luxembourgish and German.

Finally, we investigated the potential impact on instructional language proficiency in Luxembourgish and German. Consistent with cross-language transfer theories (Cha & Goldenberg, 2015; Cummins, 2008), we anticipated that strengthening heritage language skills would positively influence the acquisition of the instructional languages, particularly Luxembourgish, to which children are most exposed. We specifically explored potential transfer effects for lower-order constrained language skills, such as phonological awareness, in line with previous research (Kuo & Anderson, 2010; McCormick et al., 2021; Melby-Lervåg & Lervåg, 2011).

Method

The study was an RCT with an active control group, conducted in 16 preschools across 10 education districts in Luxembourg. Ethical approval for this study was obtained from the Ethics Review Panel of the University of Luxembourg. All procedures were carried out in accordance with the principles outlined in the Declaration of Helsinki and complied with the European General Data Protection Regulations (GDPR). Approval was also obtained from the Luxembourg Ministry of Education, school district directors, municipal councils, school presidents, and teachers. Active (opt-in) consent was obtained from parents or guardians for assessments and participation, with children providing assent.

Participants

Eligible participants were four- to five-year-old children with Portuguese as their heritage language, attending public preschools where instruction was in Luxembourgish. Based on the efficacy of prior NELI trials (closest to the current ds = .21 to .80), a power calculation determined that with 168 children ($n = 84$ per arm), the study would have > 80% power to detect a difference equivalent to Cohen's $d = .39$ ($p < .05$, two-tailed).

Children's language status was determined via a parent/carer questionnaire on languages spoken at home. Participants who met the inclusion criteria – Portuguese as their heritage language, at least one primary caregiver being a native Portuguese speaker, age 4–5 years at the intervention´s start, and no intellectual disabilities – completed pretest assessments. Thirteen children who did not understand task instructions were excluded. The CONSORT flowchart detailing recruitment, allocation, and participant flow is shown in Figure 1.

The final sample consisted of 186 children (89 girls, 97 boys) from 81 classrooms, with a mean age of 55 months at pretest. For 99.5% of children, both caregivers were native Portuguese speakers, with only one child having a caregiver who spoke a different language, while the other spoke Portuguese. Most of the children (90%) had families who immigrated from Portugal, while the rest came from other Portuguese-speaking countries, including Brazil and Cape Verde. Nearly all children (93.9%) were either born in Luxembourg or moved there before the age of one (mean length of residence: 52.84 months, $SD = 9.19$). None were enrolled in special language support programs for newly immigrated children.

Participants largely came from lower-income homes, with mothers averaging 10.5 years of formal schooling and fathers averaging 8.7 years. The average socioeconomic status, measured by the International Socio-Economic Index of occupational status (Ganzeboom & Treiman, 1996), was 38, reflecting a lower status compared to the general Luxembourg population. Additionally, 55% of the caregivers reported having fewer than 25 books at home.

Randomization was conducted by the independent York Trial Unit, https://www.york.ac.uk/healthsciences/research/trials/, ensuring unbiased allocation. Within each school, children were randomly allocated to the OL intervention group ($n = 93$) or the EM intervention control group ($n = 93$) using minimization, ensuring balance for oral language proficiency (mean z-score from expressive language task and the PPVT) and phonological awareness (mean z-score from syllable blending and segmentation) in Portuguese (Treasure & MacRae, 1998). Interventions were delivered to groups of three to four children who, in most preschools were drawn from more

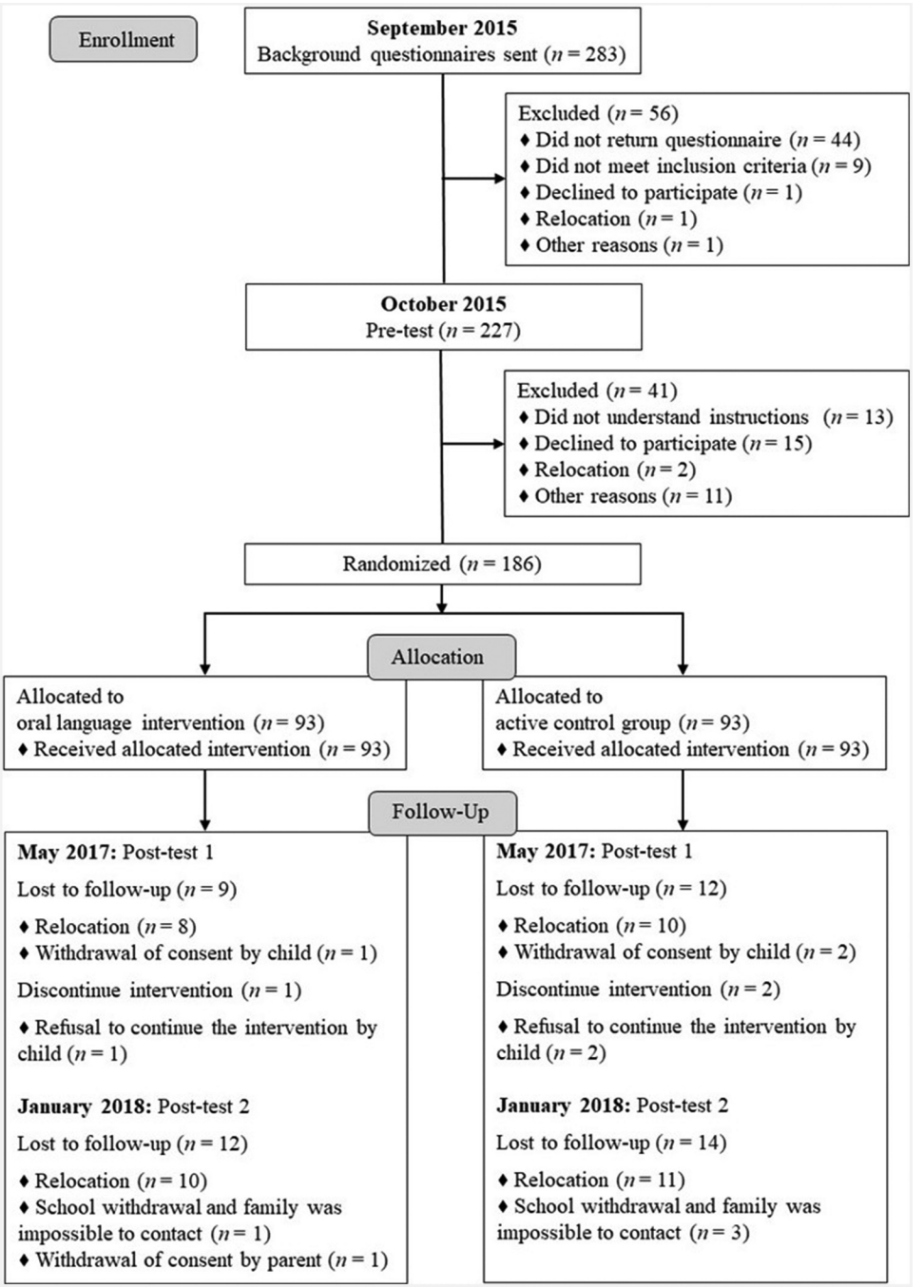

Figure 1. Consort diagram showing flow of participants through RCT.

than one classroom. Three children were excluded, to meet practical constraints on group size (3–4 children) and classroom location within the same building, maintaining balance between groups.

Two peer comparison groups were recruited for benchmark purposes: 75 classroom peers from Luxembourg evaluated on Luxembourgish vocabulary at pretest, and 44 age-matched peers from six

preschools in Northern Portugal assessed for Portuguese vocabulary (for more information, refer to Supplementary Materials, Table S1).

Assessment measures

The study design included an immediate posttest at the end of the intervention in Portuguese and Luxembourgish and a delayed follow-up nine months later, assessing proficiency in Portuguese, Luxembourgish, and German. At delayed follow-up, children had been in elementary school for approximately five months and had begun learning to read in German.

The primary outcome measures targeted taught skills and their generalization to untaught language skills in Portuguese. Secondary outcomes included transfer to oral language and preliteracy skills in Luxembourgish and German, as well as reading in German. Table 1 provides an overview of language constructs assessed at each time point.

Portuguese language skills were assessed via a comprehensive battery at pretest, immediate posttest (posttest 1), and delayed follow-up (posttest 2). The battery included expressive vocabulary (taught) and receptive vocabulary, expressive language, narrative (untaught oral language skills), phoneme awareness, and letter-sound knowledge (taught pre-literacy skills).

A reduced set of language measures was used to assess secondary oral language and early literacy outcomes in Luxembourgish and German. Luxembourgish expressive and receptive vocabulary, narrative skills, and phoneme awareness were assessed at pretest and posttest 1. At posttest 2, Luxembourgish was assessed only through an expressive vocabulary test. Since German is not part of preschool instruction and children from migrant backgrounds typically have limited exposure, German was assessed only at posttest 2, after five months of exposure in the classroom, focusing on receptive vocabulary, phoneme awareness, and reading skills.

Table 1. Language constructs assessed at the different time points.

Measures		Portuguese	Luxembourgish	German
Expressive vocabulary[1]				
	Pretest	√	√	–
	Posttest 1	√	√	–
	Posttest 2	√	√	–
Receptive vocabulary[2]				
	Pretest	√	√	–
	Posttest 1	√	√	–
	Posttest 2	√	–	√
Expressive language[3]				
	Pretest	√	–	–
	Posttest 1	√	–	–
	Posttest 2	√	–	–
Narrative				
	Pretest	√	√	–
	Posttest 1	√	√	–
	Posttest 2	√	–	–
Phoneme awareness				
	Pretest	√	√	–
	Posttest 1	√	√	–
	Posttest 2	√	–	√
Letter knowledge				
	Pretest	√	–	–
	Posttest 1	√	–	–
	Posttest 2	√	–	–
Reading[4]				
	Posttest 2	–	–	√

Note: [1]taught words from the OL intervention for Portuguese (taught measure), for Luxembourgish same words as in the Portuguese version of the test (secondary outcome); [2]Language adapted versions of PPVT for Portuguese and Luxembourgish, PDSS for German; [3]TELEX; [4]SLRT-II.

Luxembourgish and German belong to the West Germanic branch of the Indo-European language family, while Portuguese is a Romance language. Despite some Latin influence, lexical overlap between Luxembourgish/German and Portuguese is relatively low. Phonological features across these three languages show similarities and they all use a Latin alphabetic script. German orthography is considered transparent in terms of letter-sound correspondence for reading (Bergmann & Wimmer, 2008), whereas Portuguese orthography is less consistent (Seymour et al., 2003).

The sociolinguistic context presented unique challenges in developing the multilingual assessment battery. Assessments had to be culturally and linguistically appropriate for children from migrant backgrounds, capturing comparable constructs across Portuguese, Luxembourgish, and German. There is currently no objective age-of-acquisition data available for Luxembourgish, and standardized assessment tools for the language are also lacking due to the small size of the language community. Pilot work showed that standardized tests in Portuguese from Portugal and Brazil were not suitable for Portuguese-speaking children in Luxembourg, as the vocabulary and linguistic context differed. To address this, the research team developed bespoke assessment tasks in both Portuguese and Luxembourgish. These targeted the same language skills (e.g., expressive and receptive vocabulary), aiming to include words with comparable age of acquisition and frequency across languages, based on expert judgment. For example, in the expressive vocabulary task, items like *bridge* and *to cut* were used in both languages. The receptive task, modeled on the Peabody Picture Vocabulary Test (PPVT – 4, Dunn & Dunn, 2007), included words like *ring* or *farmer*. Word choices were based on presumed early acquisition, though no empirical data exist for Luxembourgish. For German, standardized tests were used for receptive vocabulary and decoding. A German phonemic awareness test was developed to align with the Portuguese measures. Measures were piloted with Portuguese-speaking migrant children in Luxembourg, with adjustments made accordingly.

Reliability of all assessment measures was evaluated using Cronbach's alpha for internal consistency and interrater reliability for tasks involving subjective scoring.

Oral language measures

Expressive vocabulary. Expressive vocabulary was assessed using a picture-naming task in both Portuguese and Luxembourgish with identical test items. Children were shown images and asked to name them in the target language. The test included 41 words for each language version (12 words from Block 1, 12 from Block 2, and 17 from Block 3), selected from the 210 words taught in the OL intervention, excluding adverbs and hard-to-depict words. Cognates accounted for 29% of the items. In addition to single language scores in Portuguese and Luxembourgish, a conceptual score was calculated, crediting children for correctly naming a word in either language (Marchman & Martínez-Sussman, 2002). Responses were recorded, transcribed offline, and coded by trained multilingual researchers. Ambiguous cases were reviewed by an expert team, including study authors, for scoring consistency. Internal reliability ranged from 0.74 to 0.85 for Portuguese, 0.76 to 0.83 for Luxembourgish, and 0.81 to 0.82 for the conceptual score.

Receptive vocabulary. Receptive vocabulary was assessed using the *Peabody Picture Vocabulary Test* (PPVT – 4, Dunn & Dunn, 2007) in both Portuguese and Luxembourgish. Children selected the pictures that matched a spoken word from a choice of four. Test items were recorded by native speakers of European Portuguese and Luxembourgish. Each language version included a practice item and 35 test items drawn from PPVT sets two through eight, with five items per set. Odd-numbered items were used for Portuguese, even-numbered for Luxembourgish. The Portuguese test included two cognates with Luxembourgish and four words taught in the intervention, while the Luxembourgish test included three cognates with Portuguese and six words taught in the intervention. Internal reliability ranged from 0.73 to 0.88 for Portuguese and 0.45 to 0.65 for Luxembourgish. Children´s receptive vocabulary in German was assessed using the noun and verb subtasks from the *Pathologischer Diagnostiktest bei Sprachentwicklungsstörung* (PDSS, Kauschke &

Siegmüller, 2009), following the manual´s procedure. Children heard a German word and selected the corresponding picture from three options. Each subtask included 20 items, with a factor score derived from both tasks. The test included two cognates with Portuguese, and internal reliability ranged from 0.67 to 0.75.

Narrative skills. Spoken narrative skills in Portuguese and Luxembourgish were assessed using the same story retelling task (Wealer et al., 2022). Children listened to a story with four pictures and retold it. Responses were recorded, transcribed, and coded offline using the CHAT transcription and coding format by trained researchers, analyzed with CLAN software (MacWhinney, 2000) to calculate mean length of utterance in words (MLUw) and total word count (NW). Narrative factor scores were computed for each language. Narrative macrostructure (story grammar, coherence, or the organization of events) was not assessed. Interrater reliability was established for 10% of responses in each language, with values ranging from 0.98 to 0.99 for Portuguese and from 0.97 to 0.98 for Luxembourgish.

Expressive language. Children's expressive language skills in Portuguese were assessed using the *Teste de Linguagem Expressiva* (TELEX), a newly developed measure. Children viewed a series of pictures depicting actions or events and were asked to describe them. The TELEX consists of 10 items, with responses recorded and transcribed for scoring. A pre-established protocol was used to assess both content/information (max score = 38) and grammatical accuracy (max score = 34). Scoring was done offline by trained researchers. The information score for each item ranged from two to seven, depending on the description´s detail. The grammar score for each item ranged from two to five, based on the use of targeted structures, including article usage, gender/number agreement, prepositions, conjunctions, adverbs, pronouns, and verb tense. Interrater reliability was established for 10% of responses, with values ranging from 0.93 to 0.98.

Code-related measures

Phoneme awareness. Phoneme awareness was assessed at pretest and posttest 1 using three subtasks in Portuguese and Luxembourgish, based on the *Test für Phonologische Bewusstheitsfähigkeiten* (Fricke & Schäfer, 2011): phoneme detection, phoneme blending, and phoneme segmenting. These measures were chosen because they are strong predictors of later reading development. Responses were scored as correct (1) or incorrect (0) with a maximum score of 15 per language. Each subtask included two training items. In the phoneme detection task (5 items), children identified which of three words shared the same initial sound as the target word, using visual support. They could either say the word or point to the picture. In the phoneme blending task (5 items), children participated in a "robot game" where the experimenter segmented words with a 1-second pause between phonemes. Children had to blend the sounds and say the full word. The phoneme segmenting task (5 items) was administered only if the child did not score at floor on blending. They were instructed to split a word into individual sounds with a short pause between each. Internal reliability was low at pretest for both languages (0.47 for Portuguese and 0.51 for Luxembourgish) due to floor effects but increased at posttest 1 (0.82 for Portuguese, 0.73 for Luxembourgish). At posttest 2, phoneme awareness was assessed in Portuguese and German using extended versions of the phoneme blending and segmenting subtasks, each with nine test items and two training items (max score = 18 per language). Internal reliability was 0.89 for Portuguese and 0.85 for German.

Letter-sound knowledge. Children identified the sound or the name of 20 Latin alphabet letters common to Portuguese, German, and Luxembourgish. Letters were presented in uppercase and lowercase on flashcards, and the task was conducted in Portuguese. Correct responses were accepted for letter sounds or names in any of the three languages. Responses were recorded and scored offline by a multilingual researcher. Internal reliability ranged from 0.89 to 0.94.

Reading skills

Emergent literacy in German was assessed using the word and nonword reading subtasks of the *Salzburger Lese- und Rechtschreibtest* (SLRT-II, Moll & Landerl, 2010), following the test manual. Children read aloud words or nonwords as quickly as possible within one minute. Responses were recorded, transcribed, and scored according to standard procedures. Internal reliability was 0.89 for word reading and 0.93 for nonword reading. Word and nonword reading scores were combined to form a factor score.

General cognitive ability

The matrix reasoning subtest of the *Wechsler Preschool and Primary Scale of Intelligence* (WPPSI-III, Wechsler, 2002) assessed nonverbal ability. Children selected the missing piece in matrices from four options. The task was administered and scored according to the manual (reliability reported: 0.86).

Socioeconomic status and language background

A caregiver questionnaire was developed in Portuguese with four sub-sections: (1) early developmental milestones; (2) language usage with and by the child; (3) background information on primary caregivers (occupation, education, language skills); (4) heritage language and literacy activities. Open-ended occupational responses were coded to ISCO codes and converted to the International Socio-Economic Index of occupational status (ISEI, Ganzeboom & Treiman, 1996). The highest ISEI score from either caregiver was used to estimate family socioeconomic status.

Procedure

Children were assessed individually in a quiet location in the school by one of the authors or trained research assistants. Tests were administered in fixed order by language. Examiners, fluent in the respective test languages, were blind to participants´ group membership. To ensure consistency, all examiners completed a two-day training program before data collection. Each child was assessed in all three languages on separate occasions. Portuguese-language measures were administered by native speakers in two sessions. Luxembourgish measures were administered by a native speaker in a separate session. At posttest 2, German assessments were administered by fluent German speakers. Assessments were conducted at multiple time points: pretest, two mid-test assessments (after 10 and 20 weeks of intervention), an immediate posttest (posttest 1), and a delayed follow-up nine months after the intervention ended (posttest 2). The present analysis focuses on pretest, posttest 1, and posttest 2 data. A detailed timeline of the assessments and intervention delivery is shown in Figure 2.

The intervention programs

Both intervention programs (OL and EM active control) were implemented over 30 weeks in preschool, divided into three 10-week blocks: the first in the second half of preschool year 1, and the remaining two in preschool year 2. Each program included 120 sessions, conducted four times per week in small groups of three to four children. Initially, sessions lasted 20 minutes, increasing to 30 minutes for the next 20 weeks, totaling 53 hours of intervention. Trained facilitators administered the sessions: The OL intervention was delivered by Portuguese-speakers, while the EM intervention was delivered by Luxembourgish-speakers, who were different from those administering the OL intervention.

Each program followed a structured schedule with predetermined content and allocated time for each component per session. Facilitators for both interventions received training and manuals outlining activities and procedures, along with all necessary materials, in advance. To promote engagement, children received participation rewards and a small gift upon completion. Parents were provided with six newsletters in Portuguese (two per block) and

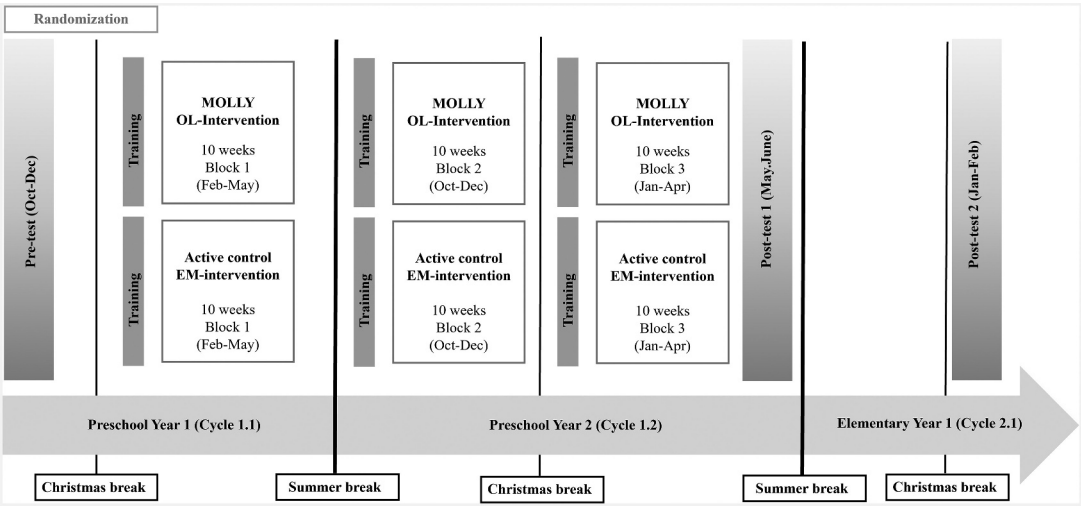

Figure 2. Timeline of project showing assessment, training and intervention phases.

supplementary materials (e.g., customized books for OL; board games for EM) at the end of each block.

The EM intervention in Luxembourgish included a tablet-based early mathematics application featuring visuospatial and numerical tasks, complemented by hands-on games (e.g., board games, memory games, and dominoes) and paper-based materials. Detailed information about the EM intervention can be found in Cornu (2018).

Oral language intervention

Children in the OL intervention received the program called MOLLY (Mother-tongue Oral Language and Early Literacy for the Young) in Portuguese, as described above. This program, based on the 30-week version of NELI (Fricke et al., 2013), included activities focused on active listening, independent speaking, vocabulary, narrative skills, phonological awareness, and letter-sound knowledge in Portuguese. The intervention adheres to best practices for oral language interventions, incorporating direct instruction, active participation, multimodal techniques, a multi-contextual approach, repetition, structure, and scaffolding (Beck et al., 2013; Carroll et al., 2011). In collaboration with teachers, parents/carers, and other educational professionals, the research team tailored content and materials to engage children from migrant backgrounds by integrating cultural elements and lived experiences. An overview of the MOLLY intervention´s structure and session schedule can be found in the Supplementary Materials (Table S2).

The listening and speaking components focused on auditory skills while encouraging independent speaking. The vocabulary component included tier one (everyday speech) and tier two (high utility) words, sourced from Portuguese children's books and lexical databases for Portuguese (DISSILEX and ESCOLEX, Soares et al., 2014). Initially, 1,749 words with age of acquisition data for children aged 3 to 6 years in Portuguese were selected. These words were translated into German and compared to Luxembourg's early elementary school vocabulary lists. From this comparison, 155 words were selected to align with the German word list for early elementary grades, while the remaining words matched those found in German textbooks used in Luxembourg schools. The final set consisted of 210 words, including nouns, verbs, adjectives, prepositions, pronouns, and adverbs, organized into 15 thematic categories. Notably, 87% of the topics covered aligned with Luxembourg´s preschool curriculum.

The narrative component reinforces taught vocabulary through storytelling, enhancing listening comprehension and inference making. Additionally, 80 short stories with corresponding pictures, including adaptations of traditional tales, engage children in familiar contexts. Phonological awareness activities progress from basic to advanced skills, including rhyme awareness, syllable awareness, phoneme identification, blending, and segmenting. The final 10 weeks focus on letter-sound knowledge. To encourage engagement, a hand puppet, "Molly the frog," is used during sessions. A video demonstrating the MOLLY intervention is available online [https://www.youtube.com/watch?v=STBzTnq2CXI].

The intervention facilitators

The OL intervention was implemented by 14 Portuguese-speaking facilitators, each assigned to a preschool, except for two smaller schools where a facilitator was shared with another participating school. Facilitators were recruited with the support of the Camões Institute, which promotes Portuguese language worldwide. All facilitators were highly proficient in Portuguese, and the majority (93%) were women with little to no proficiency in Luxembourgish or German; 80% held a bachelor's degree in either education or psychology. Prior to each 10-week intervention block, facilitators completed an 8-hour training session (totaling 24 hours) and participated in regular tutorials throughout the program.

The EM intervention was administered by Luxembourgish-speaking educators from the participating schools (one facilitator per school). These educators were not the children's primary classroom teachers. In cases where school staff could not be recruited (one school for Block 1 and two schools for Blocks 2 and 3), trained research assistants with a background in psychology delivered the EM intervention. All EM facilitators received training prior to each block (for further details see (Tomás, 2018).

Treatment fidelity

Adherence to the scripted manual was monitored by the research team for the OL intervention, with regular feedback and support provided to facilitators. Fidelity of the intervention was rated on a 4-point scale (1: several aspects missing/not satisfactory; 2: some aspects missing/not satisfactory; 3: according to manual; 4: according to manual with good use of resources). Child attendance was recorded for each session, and on-site observations with feedback occurred every two to three weeks. On average, each facilitator was observed nine times. Additionally, facilitators received support in small group tutorials (seven in total) and were video-recorded once during a teaching session. These recordings were used for reflective discussions during the tutorials. Facilitators also maintained a self-report register for each session, documenting relevant observations for discussion with the research team.

For the EM control intervention, fidelity of implementation was monitored through facilitators' session logs, which documented tasks performed, session dates, time spent, and key observations. Supervision occurred during one or two sessions per group in each block to ensure consistent implementation.

Analytic approach

The main aim of this study was to evaluate language and reading-related improvements in the heritage (proximal) and mainstream (distal) language made by the group who received the MOLLY (OL) intervention at the end of the program (post test 1) compared to the active control (EM) group, and to investigate the maintenance of gains at delayed follow-up nine months later (post test 2) as well as the effects on emergent reading skills in German at posttest 2 only. The primary outcome measures were proximal measures of language, phonological awareness and letter-knowledge in Portuguese. The secondary outcome measures were measures of language and phonological awareness in

Luxembourgish at post test 1 (only expressive vocabulary was assessed at post test 2) and of language, phonological awareness, and reading in German (post test 2).

All analyses were performed on an intention-to-treat basis in Stata 18 (StataCorp, 2023) using mixed effects regression models with random intercepts for school, to account for clustering within schools. It should be noted that given our design, with children randomly assigned to arms within each classroom and school, correcting for clustering in this way makes no appreciable difference to the standard errors of estimates of the intervention effects. Raw data (factor scores when available) were analyzed using analyses of covariance (ANCOVA) controlling for baseline performance at pretest on each variable whenever available. To check for homogeneity of regression slopes an interaction term between group and the baseline measure was included initially in all models but since none of these interaction terms were significant, they were dropped from the models.

Since there were some differences in the measures of language and reading skills across languages, we used analyses of the separate measures rather than factor scores (with the exception of narrative and reading in German). We justify our decision because (i) the intercorrelations between different language measures were low (see Supplementary Materials, Table S3); (ii) not all measures were given at each time point. We report effect sizes for group comparisons using Cohen's *d* calculated as the difference in marginal means from each ANCOVA model with the pooled SD at baseline (Morris, 2008). We focus on effect sizes when interpreting the results of the analyses.

Results

The characteristics of the children in each arm of the intervention (OL and EM active control) are presented in Table 2.

As expected, given random assignment the groups appear well matched on age, sex, socioeconomic status, general cognitive ability, and language exposure. As anticipated, all participants had higher vocabulary scores in Portuguese than Luxembourgish: for the OL group, Portuguese vocabulary, $M = 11.14$, $SD = 5.67$, Luxembourgish vocabulary, $M = 5.94$, $SD = 3.55$; for controls, Portuguese vocabulary, $M = 12.17$, $SD = 5.56$, Luxembourgish vocabulary, $M = 5.84$, $SD = 3.94$. These scores were significantly lower than those of their peers from Luxembourg (Luxembourgish vocabulary, $M = 18.59$, $SD = 7.96$) and Portugal (Portuguese vocabulary, $M = 18.64$, $SD = 6.63$), with effect sizes of group comparisons ranging from Cohen's $d = 1.14$ to 1.40 (see Supplementary Materials, Table S1).

Table 2. Characteristics of children in each arm of the intervention: mean scores with standard deviations in parentheses.

	MOLLY OL- Intervention ($n = 93$)	EM-intervention, Active control ($n = 93$)
Sex M:F	44:49	53:40
Age (months)		
Pretest	55 (3.86)	56 (3.90)
Posttest 1	74 (3.47)	74 (3.63)
Posttest 2	82 (3.64)	83 (3.65)
Socioeconomic status		
ISEI[1]	39.4 (10.94)	37.63 (10.73)
Mother, education (years)	10.65 (3.48)	10.38 (2.71)
Father, education (years)	8.99 (3.55)	8.45 (2.44)
Lived in Luxembourg (months)	52.43 (9.17)	53.25 (9.22)
General cognitive ability[2]	9.00 (2.85)	9.27 (2.93)

Note: [1]International Socio-Economic Index of occupational status; [2]WPPSI-III, Wechsler Preschool and Primary Scale of Intelligence, matrix reasoning subtest.

Table 3. Mean raw scores (SD) for the OL-language intervention and EM-intervention (active control) groups, for primary outcome measures in Portuguese pre-intervention (pre-test), immediately post-intervention (post-test 1) and delayed follow-up (post-test 2; with effect sizes for intervention effects).

		MOLLY OL intervention ($n = 93$)		Active control group ($n = 93$)			
	Reliability	*M*	*SD*	*M*	*SD*	Cohen's *d*	ANCOVA (mean differences (95% CI); *z* and *p*-values)
ExprVocabulary							
• Pre-test (41)	.84[a]	11.14	5.67	12.17	5.56		
• Post-test 1 (41)	.85[a]	22.96	6.03	19.49	6.27	0.72[1]	4.03 (2.83, 5.23); $z = 6.58$, $p < .001$
• Post-test 2 (41)	.74[a]	24.53	5.41	23.03	6.34	0.37[1]	2.10(0.70, 3.50); $z = 2.94$, $p = .003$
PPVT							
• Pre-test (35)	.73[a]	18.34	4.57	18.37	5.05		
• Post-test 1 (35)	.74[a]	26.00	4.41	24.75	4.30	0.23[1]	1.12 (0.06, 2.17); $z = 2.08$, $p = .038$
• Post-test 2 (35)	.88[a]	27.60	4.28	26.84	5.71	0.17[1]	0.82 (−0.49, 2.13); $z = 1.23$, $p = .218$
TELEX Info							
• Pre-test (38)	.93[b]	19.54	5.59	19.25	4.87		
• Post-test 1 (38)		22.05	4.90	22.43	4.87	−0.12[1]	−0.64 (−1.97, 0.69); z = −0.94, $p = .346$
• Post-test 2 (38)		24.12	4.42	23.61	4.10	0.04[1]	0.29 (−1.06, 1.50); $z = 0.34$, $p = .737$
TELEX Gram							
• Pre-test (34)	.98[b]	14.56	4.74	14.54	4.59		
• Post-test 1 (34)		16.50	4.46	17.31	4.24	−0.21[1]	−0.98 (−2.17, 0.20); $z = -1.60$, $p = .110$
• Post-test 2 (34)		18.03	4.08	18.01	3.80	−0.03[1]	−0.12 (−1.29, 1.05); $z = -0.20$, $p = .841$
NARR-MLUw							
• Pre-test	.99[b]	4.20	2.02	4.37	2.17		
• Post-test 1		7.09	1.80	6.49	2.18	0.36[1]	
• Post-test 2		6.26	1.57	6.56	1.57	−0.06[1]	
NARR-NW							
• Pre-test	.98[b]	32.62	20.14	32.11	18.27		
• Post-test 1		53.37	21.26	43.48	18.26	0.49[1]	
• Post-test 2		51.66	19.29	49.64	18.04	0.08[1]	
NARR-Factor							
• Post-test 1						0.40	0.40 (0.13, 0.67); $z = 2.87$, $p = .004$
• Post-test 2						−0.06	−0.06 (−0.36, 0.24); $z = -0.37$, $p = .708$
PhonAwareness							
• Pre-test (15)	.47[a]	0.90	1.13	1.17	1.33		
• Post-test 1 (15)	.82[a]	7.57	3.57	4.36	3.18	0.86[2]	3.21 (2.17, 4.25); $z = -6.09$, $p < .001$
• Post-test 2 (18)	.89[a]	13.47	4.77	11.58	4.72	0.52[2]	1.96 (0.38, 3.53); $z = 2.43$, $p = .015$
Letter knowledge							
• Pre-test (20)	.89[a]	0.77	2.65	0.84	1.72		
• Post-test 1 (20)	.94[a]	8.30	5.89	5.33	4.94	0.54[2]	3.07 (1.50, 4.63); $z = 3.83$, $p < .001$
• Post-test 2 (20)	.87[a]	15.04	3.81	14.35	3.62	0.14[2]	0.82 (−40, 2.03); $z = 1.31$, $p = .190$

Note: () = Maximum raw scores; ExprVocabulary = Vocabulary taught in Portuguese; PPVT = Peabody Picture Vocabulary Test; TELEX Info = Expressive Language Information Score; TELEX Gram = Expressive Language Grammar Score; NARR-MLUw = Narrative Retelling Mean Length of Utterance in Words; NARR-NW = Narrative Retelling Number of Words; NARR-Factor = Narrative Factor Score; PhonAwareness = Phoneme Awareness composite; Reliability: [a]Cronbach's alpha; [b]Interrater reliability; Cohen's *d*: 1 = difference in progress marginal means at posttest/follow-up between groups from mixed effects ANCOVA model divided by pooled initial *SD*; 2 = difference in marginal means between groups from mixed effects ANCOVA model at posttest/follow-up divided by pooled *SD* at posttest (pretest scores were at floor/not available for same measure so could not be used). A positive effect (Cohen's *d*) means that the OL Intervention group did better, whereas a negative effect means results in favor of the active control group.

Children in the OL intervention group attended more intervention sessions on average than those in the active control group (OL: $M = 98.58$, $SD = 25.70$, Range: 6–119; EM control: $M = 92.33$, $SD = 22.85$, Range: 31–118; $d = .26$, $t = 1.75$, $p = .081$). The average quality rating of the fidelity of implementation for the OL intervention group was 2.98 ($SD = 0.23$, Range: 2.00–4.00). There was no significant correlation between the number of sessions attended and improvements in language skills.

Table 4. Mean raw scores (SD) for the OL-language intervention and EM-intervention (active control) groups, for secondary outcome measures in Luxembourgish and German pre-intervention (pre-test), immediately post-intervention (post-test 1) and delayed follow-up (post-test 2; with effect sizes for intervention effects).

		MOLLY OL intervention ($n = 93$)		Active control group ($n = 93$)			
	Reliability	*M*	*SD*	*M*	*SD*	Cohen's *d*	ANCOVA (mean differences (95% CI); *z* and *p*-values)
LUXEMBOURGISH MEASURES							
ExprVocabulary							
• Pre-test (41)	.76[a]	5.94	3.55	5.84	3.94		
• Post-test 1 (41)	.84[a]	16.20	5.70	15.78	5.72	0.08[1]	0.29 (−0.81, 1.39); $z = 0.52$, $p = .601$
• Post-test 2 (41)	.83[a]	21.25	6.07	20.98	5.45	0.08[1]	0.30 (−1.19, 1.79); $z = 0.39$, $p = .697$
PPVT							
• Pre-test (35)	.45[a]	14.03	3.46	14.48	3.77		
• Post-test 1 (35)	.65[a]	22.20	4.20	20.84	4.36	0.50[1]	1.69 (0.54, 2.86); $z = 2.87$, $p = .004$
NARR-MLUw							
• Pre-test	.97[b]	3.04	2.52	3.32	2.02		
• Post-test 1		6.23	1.67	6.18	1.94	0.15[1]	
NARR-NW							
• Pre-test	.98[b]	22.28	26.70	20.38	16.45		
• Post-test 1		56.44	21.16	48.99	19.66	0.25[1]	
NARR-Factor							0.18 (−0.05, 0.42); z = 1.52, $p = .128$
PhonAwareness							
• Pre-test (15)	.51[a]	0.85	1.22	0.92	1.31		
• Post-test 1 (15)	.73[a]	5.19	2.93	4.12	2.99	0.39[2]	1.18 (0.30, 2.07); z = 2.62, $p = .009$
GERMAN MEASURES							
Receptive vocabulary – nouns							
• Post-test 2 (20)	.67[a]	15.61	3.05	15.28	3.02	0.11[2]	
Receptive vocabulary – verbs							
• Post-test 2 (20)	.75[a]	14.66	3.67	14.62	3.46	0.08[2]	
Receptive vocabulary (nouns & verbs) – Factor							0.08 (−0.15, 0.32); $z = 0.69$, $p = .487$[4]
PhonAwareness							
• Post-test 2 (18)	.85[a]	13.72	4.14	13.59	3.03	0.03[2]	0.12 (−1.10, 1.35); $z = 0.20$, $p = .842$[3]
Reading – single words							
• Post-test 2 (72)	.89[a]	3.18	3.77	3.38	4.61	−0.10[2]	
Reading – nonwords							
• Post-test 2 (72)	.93[a]	8.75	6.61	9.31	7.28	−0.08[2]	
Reading (words & nonwords) – Factor							0.09 (−0.15, 0.33);$z = 0.75$, $p = .454$[3]
LANGUAGE INDEPENDENT							
ExprVocabulary – Conceptual Score							
• Pre-test (41)	.82[a]	13.61	5.43	14.28	5.58		
• Post-test 1 (41)	.81[a]	26.76	4.96	23.89	5.26	0.58[1]	3.19 (2.26, 4.12); z = 6.74, $p < .001$
• Post-test 2 (41)	.81[a]	29.28	4.37	27.55	5.31	0.44[1]	2.11 (0.95, 3.27); $z = 3.58$, $p < .001$

Note: () = Maximum raw scores; ExprVocabulary = Vocabulary taught in Portuguese and assessed in Luxembourgish and conceptual score; PPVT = Peabody Picture Vocabulary Test; NARR-MLUw = Narrative Retelling Mean Length of Utterance in Words; NARR-NW = Narrative Retelling Number of Words; NARR-Factor = Narrative Factor Score; PhonAwareness = Phoneme Awareness composite; Reliability: [a]Cronbach's alpha; [b]Interrater reliability; Cohen's *d*: 1 = difference in progress marginal means at posttest/follow-up between groups from mixed effects ANCOVA model divided by pooled initial *SD*; 2 = difference in marginal means between groups from mixed effects ANCOVA model at posttest/follow-up divided by pooled *SD* at posttest (pretest scores were at floor/not available for same measure so could not be used). A positive effect (Cohen's *d*) means that the OL Intervention group did better, whereas a negative effect means results in favor of the active control group; ANCOVA: 3 = no covariate entered as autoregressor, 4 = pretest PPVT (Portuguese) entered as autoregressor.

Effects of intervention

Table 3 shows the primary outcome measures (Portuguese) across test points (pretest, posttest 1 and posttest 2) and group, together with effect sizes and statistical tests of group differences. Table 4 provides the same information for the secondary outcome measures in Luxembourgish and German.

Effects on portuguese language outcomes

At immediate posttest 1 there were large gains from the intervention on taught expressive vocabulary ($d = .72$), and on the primary outcome measures of PPVT ($d = .23$), narrative factor scores ($d = .40$), phoneme awareness ($d = .86$), and letter-sound knowledge ($d = .54$). There were no effects at posttest 1 on the TELEX measures of expressive language (grammar and information). Of these effects, only the effects on taught expressive vocabulary ($d = .37$), and phoneme awareness ($d = .52$) remained at delayed posttest 2.

Transfer to Luxembourgish language outcomes

At immediate posttest 1 the intervention was associated with benefits to receptive vocabulary (PPVT, $d = .50$) and phoneme awareness ($d = .39$) in Luxembourgish, but no other effects were of appreciable size.

Transfer to German language outcomes

The German outcomes were only measured at delayed posttest 2 and there was no evidence of transfer to any of these measures.

Discussion

This study used a conservative RCT with an active control group to evaluate the efficacy of a 30-week heritage language intervention aimed at strengthening oral language and preliteracy skills among Portuguese-speaking children from immigrant families. To our knowledge, this is the first study to investigate the effects of a preschool-based heritage language intervention for DLLs while assessing its impact across three languages: Portuguese (heritage language), Luxembourgish (societal and instructional language), and German (language of literacy instruction in elementary school). The intervention, delivered to small groups within mainstream preschool settings, provided Portuguese-language instruction to DLLs otherwise immersed in Luxembourgish. Language skills were assessed immediately after the intervention and again nine months later after the introduction of German literacy instruction. Oral language and preliteracy gains were compared to those of children who received a parallel early mathematics intervention delivered by Luxembourgish-speaking educators, implemented in the same classrooms during the same period.

Unlike most bilingual and heritage language programs that prioritize transitioning to the instructional language, our intervention focused on maintaining and developing the heritage language – a critical goal often overlooked. Preventing heritage language loss in DLLs with migrant backgrounds is essential, as it has been associated with educational, socio-emotional, and identity-related challenges, as well as impacts on family relationships and mental health (Ticheloven & Blom, 2025; UNESCO, 2025). The MOLLY heritage language intervention was developed based on the NELI program, an English-language intervention of proven effectiveness (Snowling & Hulme, 2025). Building on these findings, we expected positive effects on Portuguese outcomes for children in the OL intervention group compared to the active controls. Given that our intervention did not focus on language transfer, we did not anticipate broad cross-language transfer effects. However, we also did not expect any detrimental effects on instructional language outcomes in Luxembourgish and German.

Findings provide evidence for the efficacy of the intervention in fostering Portuguese language development: Children in the language intervention group showed significant gains in Portuguese

vocabulary, narrative skills, phoneme awareness, and letter-sound knowledge compared to children in the active control group. Effect sizes in this trial were similar to those reported in UK trials, where a 30-week version of the NELI intervention produced medium to large effect sizes on taught vocabulary (d = .83, Fricke et al., 2013; d = .72 in this study), narrative skills (d = .39, Fricke et al., 2013; d = .40 here), phonological awareness (d = .52, Fricke et al., 2013; d = .86 here), and letter-sound knowledge (d = .54, identical in both trials). Notably, this trial did not include individual sessions, and children were not immersed in the intervention language at school, suggesting that school-based heritage language interventions can still result in significant language gains in group settings.

An encouraging finding was that effects on Portuguese expressive vocabulary and phoneme awareness (both directly trained) persisted beyond the intervention period. However, gains in receptive untaught vocabulary, narrative skills and letter knowledge diminished over time, a common phenomenon known as "fade out" (Bailey et al., 2020; Barnett, 2011; Rogde et al., 2016). The observed fade-out in narrative skills may be due to limited exposure to social and educational contexts outside the intervention, in which narrative skills are typically honed, such as through storybook reading, storytelling, and interactions with peers and teachers. Apparent failure to maintain gains in letter-sound knowledge is likely due to catch-up of the control group during the period between post test 1 and 2 when the focus of reading instruction was on German. A meta-analytic review of RCTs concluded that fade-out is widespread across educational interventions, regardless of the specific skills targeted, though its mechanisms are poorly understood (Hart et al., 2024).

The trial also explored the impact of the heritage language intervention (in Portuguese) on the development of two languages used in mainstream school settings. Children who received the heritage language intervention made gains in Portuguese, with no negative effects on Luxembourgish or German contradicting the assumption that heritage language interventions hinder proficiency in the instructional languages. These findings challenge the "time-on-task" theory, which argues that heritage language use may impede second-language acquisition by diverting cognitive resources or instructional time (Rossell & Baker, 1996). This is particularly relevant in European educational contexts, where resistance to heritage language support is often driven by concerns that it could negatively impact proficiency in the instructional language (European Commission: Directorate-General for Education, Youth, Sport and Culture, ECORYS et al. 2017; Pulinx et al. 2017; Reljić et al. 2015).

Another question was whether reinforcing the heritage language could enhance proficiency in the languages of instruction, particularly Luxembourgish, the primary language of preschool instruction and immersion. The findings suggest that the intervention in Portuguese facilitated some cross-language transfer to Luxembourgish, specifically in receptive vocabulary and phoneme awareness, while no significant impact was observed on German. These results offer partial support for theories of cross-language transfer and facilitation effects (Chung et al., 2019).

The cross-language effects between Portuguese and Luxembourgish in phonemic awareness align with Koda's (2008) transfer facilitation model, which posits that metalinguistic skills like phonemic awareness rely on similar cognitive processes across languages. Previous correlational studies have shown significant relationships between phonological awareness in first and second languages across various language combinations (Melby-Lervåg & Lervåg, 2011). However, experimental studies with DLLs remain scarce, with a few exceptions, such as studies on French immersion in Canada and Spanish immersion in the US (Cirino et al., 2009; Wise et al., 2016). This RCT in a European context, demonstrates cross-language phonemic awareness effects between Portuguese and Luxembourgish in a setting where the instructional language differs from the intervention language, supporting results from other sociocultural contexts.

Evidence for cross-language vocabulary effects, like those from Portuguese to Luxembourgish observed here, has been mixed (Melby-Lervåg & Lervåg, 2011; Ordóñez et al., 2002). In this study, the medium effect size for Luxembourgish receptive vocabulary (d = .50) was not driven by shared cognates, as only three were included. This finding broadly aligns with the linguistic interdependence hypothesis (Cummins, 2008), which suggests that language transfer relies on a shared central

processing system, though its exact nature remains unclear (Genesee et al., 2006; Melby-Lervåg & Lervåg, 2011). Notably, we argue that the intervention led to effects on conceptual vocabulary as revealed by gains on the PPVT in both language but not on expressive vocabulary in Luxembourgish for items explicitly taught in Portuguese. Thus, we speculate that heritage language instruction may enhance language learning strategies and conceptual development, facilitating second-language vocabulary acquisition (Taatgen, 2013).

The absence of group differences on the German measures is challenging to interpret. The null results for both oral language (vocabulary) and written language (reading in a relatively transparent orthography) likely reflect the short duration of immersion. No effects were found on German receptive vocabulary, possibly due to limited exposure – only five months of classroom instruction – which may have been insufficient to support cross-linguistic transfer, a process that requires adequate exposure and motivation (Cummins, 2000). The lack of effects on German phonemic awareness were unexpected, given the transfer of training effects to Luxembourgish at posttest 1 and sustained gains in Portuguese at posttest 2. However, it needs to be borne in mind not only that the period of instruction was short but also that the German orthography is transparent and the relationships and the phonemic structure easier to extract than for other languages (Fricke et al., 2016; Wealer et al., 2022). In line with this, early differences in letter-sound knowledge may have become undetectable over time, as children generally acquire German reading skills rapidly once formal instruction begins.

Consistent with previous trials of the NELI intervention, no effects were found on word-level reading (Fricke et al., 2013, 2017). However, children were reading only three words per minute at that stage, suggesting that our measures may not have been sensitive enough to detect group differences in reading. It remains plausible that so-called "sleeper effects" may produce gains in later literacy as an effect of the intervention (see Hulme et al., 2025).

Limitations

This paper reports a novel randomized trial with DLLs, assessing effects across three languages. Such a trial is inherently resource-intensive, leading to several limitations. First, the intervention outcomes were assessed using newly developed, non-standardized measures; while reliability is reported, prior validation of these instruments would have strengthened the findings. Second, given the need to take account of participant fatigue and motivation, it was not feasible to administer every assessment in all three languages. Consequently, the evaluation of maintenance effects for the mainstream language of Luxembourgish was not possible at the delayed posttest stage, as German assessments were prioritized. Finally, while recent research (Ticheloven & Blom, 2025) highlights the positive effect of heritage language proficiency on children's emotional well-being, our study did not include measures of socio-emotional adjustment, which would be an important avenue for future research.

Conclusion

This study provides evidence that a relatively low intensity, school-based heritage language intervention, delivered over 30 weeks in small groups by trained facilitators, can significantly enhance children's heritage language skills without hindering their acquisition of the instructional language. These findings highlight the potential of heritage language programs to promote multilingual development while fostering positive educational outcomes. The study has practical relevance, as resistance to multilingual policies is often driven by the belief that heritage language use in school settings negatively impacts proficiency in the instructional language and should therefore be avoided. This study challenges that assumption, demonstrating that a structured heritage language intervention implemented in schools led to significant improvements in heritage language proficiency, no adverse effects on the instructional languages, and even benefits for

certain aspects of instructional language development. However, further research is needed to examine the long-term effectiveness, scalability, and broader implementation of such interventions. Understanding their full impact on educational and social policy could inform efforts to integrate heritage language support into mainstream education, ultimately benefiting multilingual children from migrant backgrounds and enriching their overall linguistic and cognitive development.

Acknowledgments

We are deeply grateful to all those who contributed to project coordination, the development of the intervention programs, the training of interventionists, and data collection. In particular, we would like to thank Dr. Romain Martin, Dr. Anabela Cruz-Santos, Dr. Ana Paula Vale, Dr. Lénia Carvalhais, and Dr. Rute Tomás. We also extend our sincere thanks to the interventionists, teachers, parents and children who participated, as well as to the Luxembourg Ministry of Education, Children and Youth for their valuable support.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This research was supported by the Luxembourg National Research Fund (FNR) under grant [C13/SC/5886294/POLILux](PI: Engel de Abreu).

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