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Learning to Read in the Heritage Language Supports Literacy Skills in the Majority Language
Evidence from Greek-English Speaking Children

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Abstract The first aim of the study was to investigate bilingual children's performance in language and word-level reading (i.e., decoding) at two testing points, drawing comparisons between the heritage and majority languages (Greek-English) and between two age groups in the first four years of primary school. Secondly, we investigated whether contextual factors (i.e., quality and quantity of language exposure and input) can predict language and reading development. Additionally, we addressed whether there is a contribution to the children's language scores in the heritage and majority language from Time 1 on decoding at Time 2 across languages. Forty children attending Years 1 and 3 of primary school were assessed in language and decoding skills and were then reassessed one year later in Years 2 and 4. The results showed that overall scores were higher in the majority than in the heritage language, but there were differences between the tasks in the developmental trajectory of the two languages. The results also showed more associations between contextual factors and the scores in the heritage language compared to the majority language, which suggests that the heritage language benefits from additional exposure and use. Finally, findings showed a concurrent and longitudinal relationship between phonological awareness and decoding skills, both within and between languages, supporting the orthographic transparency hypothesis.

Keywords Heritage language speakers. Phonological awareness. Decoding. Contextual factors. Cross-language transfer.

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1 Introduction

In England, the School Census (2020) results showed that the proportion of students who do not have English as their first language was 21.3% in primary schools and 17.1% in secondary schools (www.gov.uk). Often these children come from immigrant families, in which one or both parents speak a minority language (author). Therefore, these children learn two languages, the dominant language of the larger society and their family's heritage language. In the present study, we aim to investigate children's language and reading skills grown up as bilinguals in the UK and learn Greek as their heritage language and English as their dominant language. Several previous studies have investigated how children develop their dominant language.[1] In contrast, a smaller number of studies have carried out in depth examinations of how children develop and maintain their heritage language.[2]

In addition, learning to read is one of the main goals of primary education. Therefore, reading was a specific focus of the current study. The aim of the present study was to carry out a cross-sequential investigation of differences in the development of language and decoding skills between the heritage and the majority language at the beginning of primary school, and to investigate the relationship between contextual/environmental factors and the development of the children's language and reading skills. We were interested in bilingual children's language and decoding across the first four years of primary school in the UK because during these years language dominance usually shifts from the heritage to the majority language (Bylund, Abrahamsson, Hyltenstam 2012; Birdsong 2014). Our study also aimed to provide evidence of how learning to read two languages with different transparency levels may affect children's reading performance.

In what follows, we first introduce the Simple View of Reading (Hoover, Gough 1990) which provides a framework regarding the skills underlying learning to read. Then we review research on cross-language relationships between oral language and decoding skills in primary school bilingual children based on the linguistic interdependence hypothesis formulated by Cummins (1979; 1991); and research on contextual factors that contribute to heritage language and decoding skills. Our study is one of the few studies that examines the language and decoding of bilingual children longitudinally in both languages taking into account the contribution of

1 Gutierrez-Clellen, Simon-Cereijido, Wagner 2008; Chondrogianni, Marinis 2011; Verhoeven, van Leeuwe, Vermeer 2011; Chondrogianni, Marinis 2012; Hoff et al. 2012.

2 Winsler et al. 1999; Cavallaro 2005; Gathercole, Thomas 2009; Hoff 2013; Chondrogianni, Schwartz 2020.

contextual factors (i.e., language input and exposure inside and outside the home, parents' self-rated language proficiency and educational level) in the maintenance of heritage language.

1.1 Reading Development in Bilingual Children

Reading comprehension, according to the Simple View of Reading (e.g., Hoover, Gough 1990), is the product of two dimensions: decoding and linguistic comprehension. Although the Simple View of Reading was established as a framework for reading development in monolingual children, more recently it has also been applied to bilingual children (Bonifacci, Tobia 2017). Bilingual children, according to research (Babayiğit 2014), have relatively good decoding skills but can lag behind monolinguals in linguistic comprehension, which can result in some difficulties in reading comprehension, which has clear implications for progress across the curriculum. In this study, we take the Simple View of Reading as a theoretical framework, focusing on its two main dimensions: decoding and the oral language skills underlying linguistic comprehension.

An additional important factor that should be taken into account when reading development is measured is the level of orthographic transparency in the languages tested. Orthographic transparency refers to the extent to which graphemes consistently map onto one and the same phoneme, and vice versa, in an alphabetic writing system (Ziegler, Goswami 2005). The two languages spoken by bilingual children may differ in orthographic transparency, which may affect the development of the children's decoding skills in the two languages. However, very few studies have investigated how different levels of orthographic transparency along with phonological awareness skills can affect bilingual children's decoding skills (Lafrance, Gottardo 2005; Branum-Martin et al. 2012). In the present study, the heritage language is Greek, which has a transparent orthography (e.g., καλημέρα, *kalimera* 'good morning', πόρτα, *porta* 'door', γάτα, *γata* 'cat') and the majority language is English, which has a highly opaque orthography, as it has many irregular words (e.g., pint, yacht, cough). This has implications for the ease with which children learn how to read and write (Seymour et al. 2003). For example, English-speaking children may require more time to learn the foundations of decoding skills than children learning more consistent orthographies, such as Greek (Seymour et al. 2003; Ziegler, Goswami 2005; Spencer, Slocum 2010). Our study aims to provide evidence of how learning to read two languages with different transparency levels may affect children's reading performance.

1.2 Crosslinguistic Relationships in the Development of Reading and Oral Language Skills

Cummins (1979; 1991) has formulated the linguistic interdependence hypothesis, according to which certain language and literacy skills depend on a central processing system or a common underlying proficiency that is shared across languages. Thus, some literacy skills can be universal and be applied across languages, whereas others are language-specific and cannot be transferred (Durgunoğlu 2002). Cummins's (1979) linguistic interdependence hypothesis is supported by several studies that have demonstrated significant crosslinguistic relationships for literacy-related abilities, such as phonological awareness (e.g., Durgunoğlu, Nagy, Hancin-Bhatt 1993; Wang, Perfetti, Liu 2005). In addition, there is evidence showing that crosslinguistic transfer can happen in either direction (e.g., from the L1 to the L2 and from the L2 to the L1) (Verhoeven 1994; 2007). It is worth noting that crosslinguistic links between language and reading skills in one language and reading performance in the other language are often taken as evidence for positive effects of bilingualism or biliteracy (Comeau et al. 1999; Durgunoğlu, Nagy, Hancin-Bhatt 1993; D'Angiulli, Siegel, Serra 2001).

Given that bilingual children have different levels of language exposure and use in the two languages, it is important to examine the factors contributing to heritage language maintenance and majority language development and determine the relationships between oral language and decoding skills within and across languages, and the extent to which these relationships may change with development. Moreover, further research is needed to verify the evidence showing that heritage language maintenance could enhance reading skills in the majority language.

1.3 Heritage Language Acquisition

Heritage language acquisition is both related to and different from first and second language acquisition (Montrul 2006). Heritage language speakers are exposed to their heritage language from birth, like monolingual speakers, but they are also exposed to another language, which is the majority and dominant language of the region they live in. This may interact with their heritage language and may affect the children's development and maintenance of the heritage language. A significant aspect of heritage language acquisition is the age of onset of exposure to the majority language, the quality and the quantity of input and exposure in both the majority and the heritage language.

Various factors have been argued to contribute to the observed differences between the heritage language speakers, including

crosslinguistic influence from the majority language (Argyri, Sorace 2007), heritage input quantity (e.g., Gathercole, Kennedy, Thomas 2009; Flores et al. 2017; Daskalaki et al. 2019), and heritage input quality (Daskalaki et al. 2020; Paradis 2023). In the present study, input quantity will be taken to refer to the daily amount of heritage language input that children receive at home and outside the home. Input quality, on the other hand, will be taken to refer to the type of activities (e.g., reading books), parents' self-language proficiency and parental educational level.

Language use at home between parents and children is a crucial factor in determining whether the heritage language will be maintained or lost over the generations (Lao 2004). This view is also supported by other researchers demonstrating that parents' positive attitude towards the heritage language at home will affect positively the children's heritage language skills (Park, Sarkar 2007). More recently Sorenson-Duncan and Paradis (2020) demonstrated that bilingual children who received more input in their heritage language from their mothers achieved higher scores in that language. To extend this line of research, the current study examined how contextual factors can longitudinally affect language and word-level reading skills in the heritage language. Specifically, we examined the associations between language exposure and use and language and word-level reading skills with the aim of finding out their impact on language maintenance of the heritage language.

The impact of qualitative components of language exposure is now the focus of a growing amount of research (Blom, Soderstrom 2020). The quality of language exposure has frequently been related to the socioeconomic status (SES) of the family. In the language acquisition literature, SES has been operationalized as parental education (most often maternal education), household affluence (estimated from parental occupation, entitlement to free school meals, or estimated from postcodes), or indices of deprivation. Most studies employ a single measure of SES, although it has been claimed that composite measures are more useful because they capture multiple components of a child's environment (Daniela, Baldacchino, Barbara 2020). SES has been associated to bilingual children's vocabulary size (Gathercole, Kennedy, Thomas 2016; Daniela, Baldacchino, Barbara 2020), morphosyntax (Chiat, Polišenská 2016; Meir, Armon-Lotem 2017), and receptive grammar abilities (Gathercole, Kennedy, Thomas 2016; Daniela, Baldacchino, Barbara 2020). The effects of SES, however, may be varied. For example, Unsworth (2016) found that maternal education predicted receptive vocabulary scores but not morphosyntactic, semantic fluency, or accuracy sentence repetition in preschoolers. To extend this line of research, the current study examined how the contextual factors related to the input quality (i.e., parents' educational level and self-rated language proficiency) can longitudinally

affect language and word-level reading skills in the heritage language (Paradis 2023). Specifically, we examined the associations between parents' educational level and self-rated language proficiency and language and word-level reading skills with the aim to find out their impact on language maintenance of the heritage language.

1.4 Aims of the Study

The participants consisted of children in two age groups, a younger (Year 1) and an older (Year 3) group, who were tested two times in a cross-sequential design. At Time 1, the two groups were in Year 1 and Year 3 and at Time 2, they were in Year 2 and Year 4 of primary school. The focus of the study was to address the extent to which language input and exposure in and outside of the home would contribute to children's performance on measures of vocabulary, phonological awareness, and decoding skills in Greek and English over Time 1 and Time 2.

1. The first aim of the study was to investigate bilingual children's performance in measures of language and decoding skills at two testing points, between the heritage (Greek) and majority language (English) and between the two age groups in the first four years of primary school. The research question was: Did children's performance on measures of language and decoding skills differ on the basis of time (Time 1 vs. 2), language (English vs. Greek), and age (Younger vs. Older children)? The prediction was that as children progressed through school, English would become more dominant than Greek.[3]
2. The second aim was to investigate whether language use and environmental factors could impact language and reading development. Thus, the research question was: Could language use and environmental factors predict language and decoding skills in each language in Time 1 and Time 2? We hypothesized that the extent to which children would maintain their heritage language would depend on language input in and outside the home (De Houwer 2007; Gathercole, Thomas 2009; Schecter, Bayley 2004).
3. The third aim was to address whether the heritage and majority language scores at the first time point could predict decoding skills at the second time point both within and across languages. The research question was: Could Greek and English language scores at Time 1 predict decoding at Time 2 both across languages? It was hypothesized that language skills,

3 Montrul 2002; 2004; 2005; Polinsky 2007.

and mainly phonological awareness at Time 1 would contribute to reading skills at Time 2, indicating cross-language transfer effects. This is based on studies, such as Durgunoğlu (Durgunoğlu 2002), which demonstrated that phonological awareness is only acquired once in one of the child's languages and is transferred to the second language promoting reading skills.

2 Methodology

2.1 Participants

Forty typically developing Greek-English bilingual children were recruited from primary schools in the London, Reading, and Oxford areas. At Time 1, 20 attended Year 1 (Mean age = 76.6 months, SD = 3.6, 14 boys and 6 girls) and 20 attended Year 3 (Mean age = 100.4 months, SD = 3.4, 9 boys and 11 girls). Children were assessed again one school year later (Time 2), when the younger group was in Year 2 and the older group in Year 4. All children attended English mainstream primary schools and Greek supplementary schools in the UK. Supplementary schools support and maintain the heritage language and culture of immigrant communities in countries such as the UK, the USA, Canada, South Africa, and Australia (Papastergiou, Sanoudaki 2022). These schools take place every Saturday and children are taught to read and write in Greek. Most children were born in the UK, but some were born in Greece and moved to the UK at least 2 years before the commencement of the study. The children came mostly from families of average and above-average socioeconomic status. None of the children had a history of speech and/or language delay or impairment and their parents were not concerned about their language development. All children had attended reception classes in the UK (the first year of formal schooling).

2.2 Materials

Standardized and non-standardized assessments were used to measure the children's non-verbal abilities, vocabulary, phonological awareness, and decoding skills in Greek and English; a parental questionnaire measured the children's language history.

The children's non-verbal abilities were measured using the Raven's Colored Progressive Matrices (Raven, Raven, Court 2004). English vocabulary was measured using the Renfrew Word Finding Vocabulary Scale (Renfrew 1995) and Greek Vocabulary using its Greek adaptation (Vogindroukas, Protopapas, Sideridis 2009).

English phonological awareness was assessed using the blending and elision tasks from the Comprehensive Test of Phonological Processing-Second Edition (Wagner et al. 2013). For elision in Greek we used the adaptation of the elision task from the CTOPP-2 (Georgiou, Parrila, Papadopoulos 2008). There is no Greek adaptation of blending task from the CTOPP-2, therefore, we developed a task similar to the one from the CTOPP-2 using the same testing procedure. Participants listened to the sounds of a word separately and had to put them together to create the word, e.g., *i-p-n-o-s* (ύπνος 'nap'), *a-r-i-th-m-'o-s* (αριθμός 'number'). The task included five practice items that asked participants to put together two syllables to make a word. Five of the test items required the participant to put an onset and a rime together to make a word and the remaining twenty-one items required the participant to put individual phonemes together to make a word. A preliminary analysis revealed a correlation between blending and elision in both languages (Time 1: English: r =.723, p <.01; Greek: r =.775, p <.01; Time 2: English: r =.560, p <.01; Greek: r =.707, p <.01). To reduce the number of variables, we transformed these variables into composite scores. A composite score for phonological awareness was calculated by converting the raw scores for blending and elision to z scores, and then taking the mean z scores of the two tasks.[4]

English Decoding was assessed using The Test of Word Reading Efficiency (Torgesen et al. 2012) and Greek Decoding was assessed using the Greek adaption of the TOWRE-2 (Georgiou et al. 2012). Based on preliminary strong correlations between the two tasks (word reading and non-word reading subtasks) in each language (Time 1: English: r =.548, p <.01; Greek: r =.712, p <.01; Time 2: English: r =.468, p <.01; Greek: r =.648, p <.01), we created composites scores from the two tasks for each language.

The LITMUS-PABIQ questionnaire (Tuller 2015) was used to obtain data on the children's language history, quantity and quality of input, and use. The questionnaire includes sections on the child's early language history, current language skills, language used at home, languages spoken outside the home and information about the maternal and paternal education. It also includes sections about how often the child communicates in different languages.

2.3 Procedure

At both Time 1 and Time 2, children were assessed individually in a quiet room in their schools or homes. The assessments in both testing points were divided into two sessions lasting around 45 minutes

4 Composite scores were calculated in the same way for all tasks.

each. In Time 1, one session consisted of measuring the children's non-verbal IQ, English expressive vocabulary, phonological awareness, and decoding. In this session the participants' parents completed the LITMUS-PABIQ questionnaire. The other session consisted of the Greek language and literacy tasks. Time 2 assessments followed the same procedure as at Time 1, but children were not tested again on their non-verbal abilities and parents did not have to complete the PABIQ for a second time. The second testing point was one school year after the first one. The order of the sessions as well as the order of the tests within each session were counterbalanced. Parental written consent was obtained prior to onset of the data collection.

3 Results

3.1 Comparison Between the Younger and Older Children's Performance on the Two Languages at the Two Testing Points

The first research question addressed if there is a difference between the children's performance on the measures of language and decoding skills at the two testing points, between the Greek and English tasks and between the two age groups.

Table 1 summarizes younger and older children's performance on expressive vocabulary, phonological awareness, and decoding tasks in the two languages at the two testing points.

Table 1 Descriptive statistics of the children's performance on the Greek and English expressive vocabulary, phonological awareness and decoding tasks (percentage correct) at Time 1 and Time 2

		Greek				English			
		T1: Younger	**T1: Older**	**T 2: Younger**	**T 2: Older**	**T1: Younger**	**T1: Older**	**T2: Younger**	**T2: Older**
Expressive vocabulary	Mean	58.1	73.8	65.1	79.7	76.4	87.6	80.2	91.4
	SD	8.55	12.73	8.23	12.59	9.33	9.96	7.5	7.23
	Min-Max	42-70	50-94	50-76	56-98	66-100	70-100	70-94	74-100
Phonological awareness	Mean	59.18	80.94	82.13	95.25	74.88	88.75	82.50	90.75
	SD	16.33	9.86	13.91	8.7	9.82	6.56	5.38	3.81
	Min-Max	33-92	61-100	58-100	85-100	58-95	75-100	73-95	83-98
Decoding	Mean	52.93	77.27	58.79	81.12	67.76	83.68	72.03	86.86
	SD	19.13	14.66	17.73	14.59	12.1	4.74	8.66	4.68
	Min-Max	27-85	34-96	32-89	41-98	41-88	72-90	58-87	74-93

The results were analyzed using the statistical software SPSS (Gray, Kinnear 2012). To examine differences between the Age groups, between Greek and English, and between Time of testing, we entered the results (in percentages correct) into repeated-measures ANOVAs with Age group (younger, older) as the between participants factor, Language (Greek, English) and Time (Time 1, Time 2) as the within participants factors, for each task separately. The analysis on the expressive vocabulary tasks showed a significant main effect of Time (F (1, 38) = 30.87, p <.001, $\eta p2$=.448), a significant main effect of Language (F (1, 38) = 85.61, p <.001, $\eta p2$=.693), and significant Language by Age (F (1, 38) = 10.52, p =.002, $\eta p2$=.217), Time by Language interaction (F (1, 38) = 257.29, p <.001, $\eta p2$=.867), and Time by Language by Age Interactions (F (1, 38) = 10.57, p =.002, $\eta p2$=.566). To explore the 3-way interaction, we split the file based on Age (younger vs. older) and we looked at the 2-way interaction between Language and Time. The analysis for the Younger group showed a significant main effect of Time (F (1, 19) = 48.43, p <.001, $\eta p2$=.718), a significant main effect of Language (F (1, 19) = 42.63, p <.001, $\eta p2$=.692), and a significant interaction between Language and Time (F (1, 19) = 4.49, p <.05, η_p^2 =.191). The results of the Older group showed a significant main effect of Time (F (1, 19) = 8.41, p =.009, $\eta p2$=.306), a significant main effect of Language (F (1, 19) = 45.31, p <.001, $\eta p2$=.704), but the interaction between Language and Time was not significant (F (1, 19) =.518, p = ns.). To explore the significant interaction in the Younger group we run simple effects tests. Both at Time 1 and Time 2, children were better in English than Greek (Time 1: F (1, 19) = 47.59, p <.001, η_p^2 =.715; Time 2: F (1, 19) = 31.72, p <.001, η_p^2 =.625). The children's performance was significantly better at Time 2 than at Time 1 in both languages (Greek: F (1, 19) = 27.87, p <.001, η_p^2 =.595; English: F (1, 19) = 24.58, p <.001, η_p^2 =.564). The interaction is likely to have resulted from the larger effect size in the difference between English and Greek at Time 1 (.715) compared to Time 2 (.625), suggesting that the difference between Greek and English in Time 1 is smaller than in Time 2.

The analysis on the phonological awareness tasks showed a significant main effect of time (F (1, 38) = 317.84, p <.001, $\eta p2$=.893), a significant main effect of age (F (1, 38) = 49.61, p <.001, $\eta p2$ =.566), but no significant effect of language (F (1, 38) = 1.31, p =.260, $\eta p2$=.033). The time by age interaction was not significant (F (1, 38) = 1.01, p =.321, $\eta p2$=.026), but the language by age, time by language as well as the time by language by age interactions were significant (F (1, 38) = 10.52, p =.002, $\eta p2$=.217, F (1, 38) = 257.29, p <.001, $\eta p2$=.867 and F (1, 38) = 10.57, p =.002, $\eta p2$=.566, respectively).

To explore the 3-way, time by language by age interaction, we split the file based on Age (younger vs. older) and we looked at the 2-way interaction between Language and Time. The analysis for the

Younger group showed a significant main effect of Time (F (1, 19) = 147.93, p <.001, $\eta p2$=.886), a significant main effect of Language (F (1, 19) = 6.47, p <.05, $\eta p2$=.254), and a significant interaction between Language and Time (F (1, 19) = 86.56, p <.001, η_p^2 =.82) in PA scores. The results of the Older group also showed a significant main effect of Time (F (1, 19) = 177.89, p <.001, $\eta p2$=.903), a significant main effect of Language (F (1, 19) = 4.29, p <.05, $\eta p2$=.184), and a significant interaction between Language and Time (F (1, 19) = 163.52, p <.001, $\eta p2$=.896). To explore the significant simple interactions between language and time, we run simple effects tests, separately for the younger and older groups. In the younger group, the children's performance was significantly better in Time 2 than in Time 1 in both languages (Greek: F (1, 19) = 207.22, p <.001, η_p^2 =.916; English: F (1, 19) = 29.23, p <.001, η_p^2 =.606). The clearest source of the interaction was that at Time 1 the children performed better in English than Greek (F (1, 19) = 20.77, p <.001, η_p^2 =.522), but at Time 2, this difference disappeared (F (1, 19) =.015, p =.904, η_p^2 =.001).

In the older group, the children's performance in Greek PA was significantly better in Time 2 than Time 1 (F (1, 19) = 264.46, p <.001, η_p^2 =.933), but this was not the case for English (F (1, 19) = 2.99, p =.100, η_p^2 =.136). At Time 1 the children performed better in English than Greek (F (1, 19) = 12.41, p =.002, η_p^2 =.395), but this changed at Time 2; the children were significantly better in Greek than English (F (1, 19) = 66.04, p <.001, η_p^2 =.777).

The analysis of the decoding tasks showed a significant main effect of Time (F (1, 38) = 42.01, p <.001, $\eta p2$=.526), a significant main effect of Language (F (1, 38) = 21.52, p <.001, $\eta p2$=.362), and a significant main effect of Age (F (1, 38) = 32.25, p <.001, $\eta p2$ =.459). The Time by Age, the Language by Age, the Language by Time, and the Time by Language by Age interactions were not significant (F (1,38) = 1.37, p =.249, F (1,38) = 3.38, p =.074, F (1,38) =.771, p =.385, and F (1,38) =.126, p =.724 respectively) suggesting that both younger and older children had higher scores in Time 2 than in Time 1 and achieved higher scores in English than Greek.

3.2 Contextual Factors as Predictors of Language and Word Reading Measures in the Heritage Language

The second research question addressed whether there is a relationship between the contextual factors and the development of language and reading measures in the heritage language (i.e., Greek). Specifically, we examined whether the effects of language exposure and input on children's heritage language skills are consistent at the two testing points.

To examine the relationships between parental report measures of children's language exposure and proficiency level, parental level

of education, parental rating of their own language proficiency, and the measures of children's language and decoding skills in Greek at Time 1, Pearson's correlations were conducted, as shown in Table 2. We used the composite scores where we had more than one measure per construct: the parental reports and tasks measuring expressive vocabulary, phonological awareness, and decoding at Time 1. The analysis revealed that overall, children's performance on the majority of the Greek tasks was significantly positively correlated with Greek language use outside the home at Time 1, as shown in Table 2. Expressive vocabulary was significantly positively correlated with language use in the home and outside the home. The score of the decoding task was significantly positively correlated with language use outside the home and parental educational level.

Table 2 Correlation matrix showing correlations between children's performance on objective measures and parent-questionnaire measures of language exposure before 4 years and language use in and outside home, parents' educational level and parents' self-rated language proficiency in Greek, testing point 1

	1.	2.	3.	4.	5.	6.	7.
1. Expressive.Vocabulary.Gr.1							
2. Phonological.Awareness.Gr.1	.42**						
3. Decoding.Gr.1	.47**	.67**					
4. Greek Exposure before 4 years old	.10	.02	.10				
5. Language use in home	.41**	.10	.09	.12			
6. Language use outside home	.54**	.31	.34**	.11	.71**		
7. Parents.Educational.Level	0	.13	.33**	.37*	.13	.23	
8. Parents.Proficiency.Level.Gr	.20	.31	.21	.23	.18	.27	.14

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Gr. = Greek
Regression analysis: predictors of Greek expressive vocabulary at Time 1

Additionally, the second research question addressed whether parental report measures of language exposure and level could predict the objective measures of the language and decoding skills in Greek. To address this question, we used multiple regressions. In each case, only those variables yielding significant bivariate correlations with the criterion variable were included in the regression. Prior to the analysis, the data was screened to ensure that the assumptions underlying the use of regression analysis were met.

A standard multiple regression was performed on Greek expressive vocabulary as the dependent variable and language use in the home and language use outside the home as the independent variables. Prior to the analysis the data was screened to ensure that the assumptions underlying the use of regression analysis were met. The

results are summarized in Table 3, which shows that the regression model was significant, and that language use outside the home, but not inside the home, accounted for unique variance in Greek expressive vocabulary scores.

Table 3 Summary of multiple regression analyses for variables predicting children's performance on expressive vocabulary in Greek (N = 40)

	Expressive Vocabulary		
Variable	B	SE B	β
Language use in home	.401	1.36	.058
Language use outside the home	2.86	1.12	.499*
	R^2 =.293, F = 7.67**		

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Regression analysis: predictors of Greek decoding at Time 1

A simple linear regression was performed on Greek decoding as the dependent variable and language use outside the home and parents' educational level as the independent variables. The results are summarized in Table 4, which shows that the regression model was significant, and that language use outside the home and parents' educational level accounted for unique variance in Greek decoding scores.

Table 4 Summary of multiple regression analyses for variables predicting children's performance on decoding in Greek (N = 40)

	Decoding
Variable	B SE B β
Language use in home	
Language use outside the home	3.71 1.42.363*
Parents' educational level	6.27 3.03.318*
	R^2 =.135, F = 4.53*

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Overall, the regression analyses showed that language used outside the home was a significant unique predictor for almost all the tasks in Greek, as shown in Tables 3 and 4.

To examine whether the effects of the contextual factors, and especially the effects of language exposure and use, change over the time as children progress in school, we run Pearson's correlations including the parents' reports and children's performance on language and word-level reading measures at Time 2 for each language separately. The results showed that the children's performance on

the Greek language tasks was significantly positively correlated with Greek language use outside the home at Time 2. As in Time 1, expressive vocabulary was significantly correlated with language use outside the home and the score of the decoding tasks was significantly correlated with parents' educational level. Expressive vocabulary was also positively correlated with parents' level of proficiency, as shown in Table 5.

Table 5 Correlation matrix showing correlations between children's performance on objective measures and parent-questionnaire measures of language exposure before 4 years and language use in and outside home, parents' educational level and parents' self-rated language proficiency in Greek, testing point 2

	1.	2.	3.	4.	5.	6.	7.
1.Expressive.Vocabulary.Gr.2							
2.Phonological.Awareness.Gr.2	.43**						
3.Decoding.Gr.2	.40**	.68**					
4.Greek Exposure before 4 years old	.02	.05	.04				
5.Language use in home	.27	.20	.03	.12			
6.Language outside home	.50**	.28	.21	.11	.71**		
7.Parents.Educational.Level	.13	.11	.05	.37*	.13	.23	
8.Parents.Proficiency.Level.Gr	.33*	.29	.23	.23	.19	.28	.14

*. Correlation is significant at the 0.05 level (2-tailed).

Additionally, we investigated whether parental report measures of language exposure and level at Time 1 could predict the objective measures of the various language and reading measures in Greek at Time 2. To address this question, we used multiple regressions. In each case, only those variables yielding significant bivariate correlations with the criterion variable were included in the regression. Prior to the analysis the data was screened to ensure that the assumptions underlying the use of regression analysis were met.

Regression Analysis: Contextual Predictors of Greek Expressive Vocabulary at Time 2

A standard multiple regression was performed on Greek expressive vocabulary as the dependent variable and language use outside the home and parents' level of proficiency as the independent variables. The results are summarized in Table 6, which shows that the regression model was significant, and that language use outside the home, but not parents' level of proficiency accounted for unique variance in Greek expressive vocabulary scores.

Regression Analysis: Contextual Predictors of Greek Decoding at Time 2

A simple linear regression was performed on Greek decoding as the dependent variable and parents' educational level as the independent variable. The results are summarized in Table 6, which shows that the regression model was significant, and that parents' educational level accounted for unique variance in Greek decoding scores.

Table 6 Summary of multiple regression analyses for variables predicting children's performance on Greek expressive vocabulary and decoding at Time 2 (N = 40)

	Expressive vocabulary			**Decoding**
Variable	B	SE B	β	B SE B β
Language use outside the home	2.43	.80	.439**	
Parents' self-rated language proficiency	4.39	3.02	.209	
Parents' educational level				6.43 2.87.361*
	R^2 =.249, F = 7.46**			R^2 =.130, F = 5.68*

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Overall, the results showed that the effects of Greek language exposure and input on Greek language skills are similar across Time 1 and Time 2 indicating that there is consistency between the two testing points regarding the role of contextual factors for Greek. Additionally, the findings confirmed that heritage language use is important for the heritage language but does not have an impact on the majority language.

3.3 Cross-Language Effects Between Greek and English Language and Reading Skills

The third research question addressed whether language skills at Time1 can predict reading skills at Time 2 both within and across the languages. Prior to the regression analysis, we examined the within- and cross-language correlations between Greek and English expressive vocabulary and phonological awareness at Time 1 and decoding at Time 2, with simple correlations shown above the diagonal in Table 9. The variables were residualized for age (Durand et al. 2005) and correlations between the resulting age-independent variables shown below the diagonal in the Table 7.

In terms of correlations between the oral language skills and decoding, there were significant positive within language associations. Specifically, Greek phonological awareness at Time 1 was significantly associated with Greek decoding at Time 2. English phonological awareness at Time 1 was significantly correlated with English decoding at Time 2.

In terms of correlations between the oral language skills and decoding, there were significant positive cross-language associations. Greek phonological awareness at Time 1 was significantly associated with Greek and English decoding at Time 2. English phonological awareness at Time 1 was significantly correlated with Greek and English decoding at Time 2. Greek inflectional morphology at Time 1 was significantly correlated with English decoding at Time 2.

Overall, the results showed that phonological awareness is significantly associated with decoding both within and across languages.

Table 7 Correlations for children's performance on expressive vocabulary, phonological awareness and decoding in Greek and English at two testing points, with zero-order correlations above the diagonal, and correlations between age-controlled variables below the diagonal

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.Expressive Vocabulary.Gr.1	-	.60**	.42**	40**	.46*	.56**	.77**	.60**	.41**	.56**
2.Expressive Vocabulary.Eng1	.43***	-	.37*	37*	.27	.54**	.46**	.81**	.19	.57**
3.Phonological Awareness.Gr.1	.07	.07	-	.63**	.34*	.33*	.48**	.47**	.64**	.72**
4.Phonological Awareness.Eng.1	.03	.06	.37*	-	.35*	.44**	.36*	.48**	.69**	.70**
5.Expressive Vocabulary.Gr.2	.66**	.24	.18	.02	-	.49**	.38*	.35*	.40**	.50**
6.Expressive Vocabulary.Eng.2	.37*	.73**	.13	.13	.10	-	.44**	.59*	.38*	.59**
7.Phonological Awareness. Gr.2	.06	.07	.85*	.25***	.03	.15	-	.48*	.68**	.68**
8.Phonological Awareness.Eng.2	.05*	.19	.30	.75***	.06	.14	.24	-	.54**	.65**
9.Decoding.Gr.2	.11	.15	.44**	.41*	.11	.04	.46	.26	-	.68**
10.Decoding.Eng.2	.16	.24	.48*	.43**	.14	.27	.34*	.30	.46**	-

***. Correlation is significant at the 0.001 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Additionally, we run multiple regression to investigate the contribution of Greek and English language variables to Greek and English reading skills using the variables residualized for age.

Regression analysis: predictors of Greek decoding

A standard multiple regression was performed on Greek decoding at Time 2 as the dependent variable and Greek and English phonological awareness at Time 1 as the independent variables. Prior to the analysis the data were screened to ensure that the assumptions were met. The results are summarized in Table 8, which shows that the regression model was significant, and that Greek phonological awareness was a significant predictor of Greek decoding scores. Moreover, English phonological awareness accounted for additional unique variance in Greek decoding at Time 2, providing evidence of crosslinguistic transfer.

Table 8 Summary of multiple regression analyses for variables predicting children's performance on Greek decoding at Time 2 (N = 40)

	Greek decoding.2		
Variable	B	SE B	β
Phonological Awareness.Gr.1	.467	.171	.412**
Phonological Awareness.Eng.1	.667	.272	.368*
R^2	.24318.26**		
F			

Gr. = Greek, Eng. = English
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Regression analysis: predictors of English decoding

A standard multiple regression was performed on English decoding at Time 2 as the dependent variable and Greek phonological awareness and English phonological awareness at Time 1 as the independent variable. Prior to the analysis the data were screened to ensure that the assumptions were met. The results are summarized in Table 9, which shows that the regression model was significant, and that English phonological awareness was significant predictor of English decoding scores. Moreover, Greek phonological awareness at Time 1 accounted for additional unique variance in English decoding at Time 2, providing evidence of crosslinguistic transfer.

Table 9 Summary of multiple regression analyses for variables predicting children's performance on English decoding at Time 2 (N = 40)

	English decoding.2		
Variables	B	SE B	β
Phonological Awareness.Gr.1	.157	.086	.266*
Phonological Awareness.Eng.1	.274	.124	.368**
R^2		.52424.61**	
F			

Gr. = Greek, Eng. = English
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

4 Discussion

The first aim of the study was to investigate bilingual children's performance in objective measures of language and decoding skills at two testing points, between the heritage (Greek) and majority language (English) and between the two age groups in the first four years of primary school. The second aim was to investigate the relationship between language use, environmental factors and language and reading development. The third aim was to address whether there is a relationship between the heritage and majority language at the first time point and decoding skills at the second time point within and across languages. The prediction was that as children progress through school, English would become more dominant than Greek, and that the extent to which they would maintain their heritage language would depend on language input in and outside the home. Additionally, it was hypothesized that language skills at Time 1 would be associated with decoding skills at Time 2, indicating within and cross-language transfer effects. This is based on studies, such as Durgunoğlu (2002), which demonstrated that phonological awareness is only acquired once in one of the child's languages and is then transferred to the second language promoting reading skills in that language (the second language). In the present study, the children grew up in the UK with Greek as a heritage language and English as a majority language and they attended English mainstream schools. As a result, English was expected to be the children's dominant language.

4.1 Comparison of the Children's Performance on Language and Literacy Tasks Based on Time, Language and Age

The first research question of our study was to investigate whether the children's performance on objective measures of language and decoding skills differs on the basis of time (Time 1 vs. 2), language (English vs. Greek), and age (Younger vs. Older children). The results showed overall higher scores in the majority language (English) compared to the heritage language (Greek), but there were differences in terms of the developmental trajectory of the two languages between the tasks. There was a linear development in vocabulary and decoding skills with older children showing higher scores than younger children and higher scores in the second compared to the first testing time. In phonological awareness, the difference between the majority and heritage language closed in the second testing time. This is in line with previous studies demonstrating that bilingual children often have better skills in the majority compared to the heritage language (Montrul 2002, 2004, 2005; Polinsky 2007). Montrul (2004) underscored that heritage speakers exposed to their heritage language are less likely to have severe loss of their heritage language (Spanish). Similarly, our results showed that children continue to develop their heritage language skills across the first years of primary school.

Another important finding is that younger children performed similarly in Greek and English phonological awareness tasks at Time 2, while older children were better in Greek than English phonological awareness tasks at Time 2. This could be explained by the fact that Greek is a more transparent language than English. Lafrance and Gottardo (2005) demonstrated that orthographic depth appears to contribute in terms of factors related to reading, such as phonological awareness.

4.2 Contextual Factors as Predictors of Heritage Language and Decoding Skills

The second aim of our study was to investigate the relationship between the contextual factors and the children's language and decoding skills in the heritage language (Greek) in Time 1 and Time 2. The questionnaire provided evidence about the children's exposure to both Greek and English in the home and outside the home before attending school (before the age of 4 years) and also at the time this study was conducted, as well as information about the parental level of education and language proficiency.

Focusing on Greek as a heritage language, at Time 1 vocabulary and phonological awareness tasks were significantly correlated with language use at home and outside the home. Additionally,

performance on decoding was significantly correlated with Greek language use outside the home and parents' educational level. At Time 2, vocabulary was significantly correlated with Greek outside the home. The scores of vocabulary were significantly associated with the parents' level of Greek proficiency and also, decoding appeared to be significantly correlated with the parents' educational level.

Overall, the results showed that the effects of Greek language exposure and input on Greek language skills are similar across Time 1 and Time 2, indicating that there is consistency in the two testing points regarding the role of exposure to Greek. Additionally, the results confirmed that language use is important for the heritage language but not the majority language. These findings are in line with previous studies underlining the importance of language exposure and use in heritage language development (De Houwer 2007, Gathercole, Thomas 2009; Schecter, Bayley 2004). Specifically, De Houwer (2007) and Gathercole and Thomas (2009) demonstrated that children often develop high competence in their dominant language because they usually receive a sufficient amount of exposure to that language, while the amount of use and exposure is a crucial factor for the heritage language development. Additionally, we found that parents' Greek proficiency was positively associated with the children's performance on the Greek oral tasks at both testing points. Indeed, several studies have shown that parents' increasing use of English (L2) at home had no impact on the children's English development. On the other hand, parents not speaking their heritage language at home seems to negatively affect the children's heritage language skills (Hammer et al. 2009). This is one of the few studies examining longitudinally the effects of language exposure and use on heritage language and bilingual children's development of oral language and decoding skills. Future studies could examine participants with different levels of language proficiency in the heritage language to investigate this point further.

4.3 Cross-Language Transfer between the Greek and English Tasks Based on Time 1 and Time 2

The third aim of our study was to investigate whether language skills at Time 1 could predict decoding skills at Time 2, indicating cross-language transfer effects. The results showed that Greek and English phonological awareness tasks contributed to Greek decoding. Similarly, English and Greek phonological awareness tasks predicted English decoding.

Our findings are in line with the hypothesis that phonological awareness is strongly related to decoding skills in alphabetic orthographies. For example, demonstrated that phonological skills in both

languages are concurrent predictors of decoding in both languages. Given the view that phonological awareness is universal, once acquired, it will affect reading skills cross-linguistically and the transfer should be bidirectional (Durgunoğlu 2002). Durgunoğlu, Nagy and Hancin-Bhatt (1993) found that Spanish phonological awareness could predict English decoding, indicating cross-language transfer. However, Spanish and English oral proficiency did not contribute to reading performance. The authors argued that phonological awareness was a significant predictor of word reading both within and across languages. Moreover, they underlined that oral proficiency should be associated with reading skills, but possibly not with all the aspects of reading skills. Similarly to our study, phonological awareness was a longitudinal predictor of decoding both within and across languages.

5 Conclusion

The first aim of the study was to investigate bilingual children's performance in objective measures of language and decoding skills at two testing points, between the heritage (Greek) and majority language (English) and between the two age groups in the first four years of primary school. The second aim was to investigate whether the contextual factors (i.e., language use and environmental factors) could predict language and reading development. The third aim was to address whether language skills at Time 1 could predict decoding at Time 2 both within and across languages.

This is one of the few studies to examine bilingual children's performance in both of their speaking languages at two testing points. It also provided evidence about the relationship between language exposure and language and reading development in the same population of bilingual children in both heritage and majority language. It examined the cross-language relationships of language and reading skills when the pair of spoken languages differ in terms of their orthographic transparency.

The results showed that overall, scores were higher in the majority language (English) compared to the heritage language (Greek), but there were differences in terms of the developmental trajectory of the two languages between the tasks. There was linear development in vocabulary and decoding with older children showing higher scores than younger children and higher scores in the second compared to the first testing time. In phonological awareness, the difference between the majority and heritage language closed at the second testing time. The results also showed more associations between language exposure, use, and environmental factors and the scores in the heritage language compared to the majority language.

This is likely to reflect that the majority language is so pervasive in the children's lives through schooling and life in the UK that exposure, use, and environmental factors are leveled out (Papastergiou, Sanoudaki 2022). Moreover, the heritage language can benefit from additional exposure, use, and environmental support. Finally, findings showed that phonological awareness was a concurrent and longitudinal predictor of decoding skills both within and across-languages (Durgunoğlu 2002; Lafrance, Gottardo 2005), supporting firstly the view that learning a first language with more transparent orthography could enhance skills in the second language with more opaque orthography and secondly the interdependence hypothesis (Cummins 1979; 1991). In addition, this finding demonstrates that supporting reading skills in the heritage language benefits reading skills in both languages spoken by bilingual children and supports the linguistic interdependence principle (Cummins 1979).

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