HHS Public Access

Author manuscript

Int J Biling Educ Biling. Author manuscript; available in PMC 2023 June 27.

Published in final edited form as:

Int J Biling Educ Biling. 2022 ; 25(10): 3907–3923. doi:10.1080/13670050.2022.2090226.

Cross-linguistic differences in the associations between morphological awareness and reading in Spanish and English in young simultaneous bilinguals

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Abstract

This study aimed to clarify the relations between morphological awareness and literacy skills in Spanish and English in young simultaneous bilingual learners. Guided by theoretical perspectives on the associations between morphological awareness and word- versus sentence-level literacy skills, and their transfer between bilinguals' two languages, we asked bilingual children (N = 90; M = 8.07 years old) to complete dual-language literacy assessments. First, we observed cross-linguistic differences in the associations between morphology and reading. In English, morphological awareness was directly related to word reading and reading comprehension, whereas in Spanish, the association with reading comprehension was fully mediated by vocabulary and single word reading. Second, we observed cross-linguistic associations from English word reading to Spanish reading comprehension, and from Spanish reading comprehension to English reading comprehension. Our findings inform bilingual literacy theory by revealing both cross-linguistic differences and bidirectional associations between literacy skills across typologically-distinct orthographies. In particular, children's word-level skills transferred from the language of schooling (English) into their heritage language (Spanish), and their broader reading comprehension skills transferred from the heritage language to support English. Taken together, these findings support the value of bilingual heritage language maintenance for reading achievement in children's dominant language of literacy instruction.

Keywords

Biliteracy; heritage languages; morphological awareness; reading comprehension; dual first-language acquisition; cross-linguistic transfer

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Morphological awareness (MA), or sensitivity to the smallest units of meaning, is associated with successful word reading and reading comprehension across languages (Kuo & Anderson, 2006). However, because learning to read varies across languages (Ziegler & Goswami, 2005), there may be cross-linguistic differences in the role of MA in successful literacy. Bilingual research suggests that MA may transfer between a bilingual's two languages (Chung et al., 2019). Yet the interplay between young bilingual learners' morphology skills across languages, and their relation to literacy within and between languages, remain poorly understood. This study examines young Spanish-English bilinguals with high dual-language proficiency to address two questions. First, are there cross-linguistic differences between English and Spanish in the associations between morphological awareness, word reading, and reading comprehension? Second, do morphological awareness and word reading skills in one language transfer to support literacy in the other?

Cross-linguistic variation in learning to read

Learning to read varies across languages. Psycholinguistic Grain Size Theory (PGST; Ziegler & Goswami, 2005) suggests that languages vary in the size of the linguistic unit that is key to literacy. In Spanish, sound-to-print associations are highly consistent, allowing readers to rely on a small grain size for word reading; this is known as a "shallow orthography." English, a comparatively "deep orthography," has less predictable sound-to-letter mapping than Spanish. In some cases, one phoneme might be spelled multiple ways (such as the */k/* sound in *castle, kitten, locker,* and *echo*). In other cases, spelling might remain consistent across words to maintain the underlying morphemic structure, even when the phonology changes (e.g., *music-musician* or *heal-healthy*). As a result, English readers may need to rely on larger grain sizes, such as morpho-syllables, to successfully read words (Ziegler & Goswami, 2005). The varying emphasis on sound- and meaning-to-print associations across languages further influences children's relative reliance on various metalinguistic skills. Although reading largely relies on the same cognitive skills across languages, children come to recruit these resources differently based on language-specific demands (e.g., McBride-Chang et al., 2005). Young bilingual readers thus present an opportunity to examine how these cross-linguistic differences may lead to principled variations in reading mechanisms within a single mind.

Morphological awareness in English and Spanish literacy

The present study investigates the role of morphological awareness in word reading and reading comprehension in bilingual Spanish-English readers. The ultimate goal of reading is to understand meaning. Children's sensitivity to units of meaning can be understood along a developmental continuum from an implicit to explicit understanding of how morphemes are combined to form words (Carlisle, 2004). Studies of older readers often investigate the role of children's explicit knowledge of morphemic structure in successful reading; in contrast, studies of younger children typically assess MA in terms of children's implicit knowledge. MA contributes to reading development across languages (Kuo & Anderson, 2006). However, the precise role of MA in reading, and its association to other literacy skills, may vary (Desrochers et al., 2018).

The Reading Systems Framework (Perfetti & Stafura, 2014) suggests that morphology contributes to reading comprehension in two ways: first, as a component of the lexicon which directly influences word reading, and second as part of a child's general linguistic system, influencing comprehension processes. Aligned with this perspective, there is a growing body of evidence that MA contributes to both word- and passage-level reading. First, MA makes a direct contribution to English word reading across diverse learners (Deacon et al., 2014; Kieffer & Box, 2013; Sun et al., 2021). This evidence is aligned with PGST (Ziegler & Goswami, 2005), which predicts that the low sound-to-print predictability of English may prompt readers to rely on larger morpho-phonological units. MA may also contribute directly and indirectly to reading comprehension through word-level processes. For instance, a study of 3rd grade English readers revealed a direct effect of MA on reading comprehension as well as two significant indirect pathways: through morphological analysis (inferring meaning of morphologically complex words), as well as through morphological decoding (correct oral reading of polymorphemic words) and single word reading (Levesque et al., 2017). Others have found that MA supports reading comprehension through listening comprehension (Gottardo et al., 2018) and reading vocabulary (Kieffer & Box, 2013; Kieffer & Lesaux, 2012a).

There is a lesser consensus on the mechanisms by which morphology contributes to Spanish literacy. On one hand, PGST might suggest that MA is unnecessary for Spanish word reading, as sound-to-letter mapping may be largely sufficient. In line with this perspective, study of Argentine 4th graders with Spanish as a first language revealed a direct association between morphology and reading comprehension, and no direct contribution to word reading (D'Alessio, Jaichenco, et al., 2019). On the other hand, the phonological transparency of Spanish may allow children to use a small grain size to access larger morphemic units early in reading acquisition (e.g., Manolitsis, Grigorakis, & Georgiou, 2017). Furthermore, the orthographic regularity and/or the richness of Spanish morphology may make it easier for learners to internalize morphemes, facilitating word recognition (Antzaka et al., 2021; Lázaro et al., 2017). Indeed, a study of monolingual speakers of Brazilian Portuguese – a closely related, transparent Romance language – revealed contributions of MA to word reading and listening comprehension, but *no* direct association with reading comprehension (Oliveira et al., 2020). As there have been relatively fewer studies of morphology and typical reading development with Spanish monolinguals (D'Alessio, Jaichenco, et al., 2019; D'Alessio, Wilson, et al., 2019; Lázaro et al., 2017, 2021), the precise role of MA in Spanish reading comprehension remains an open question.

In studies of English reading development, morphology and vocabulary can be difficult constructs to disentangle (Spencer et al., 2015). First, MA, vocabulary, and reading development are reciprocally related (Kieffer & Lesaux, 2012b; Wagner & Meros, 2010). MA has been linked to vocabulary learning in monolingual English speakers (McBride-Chang, Wagner, et al., 2005) as well as bilinguals (Zhang, Koda & Leong, 2016). Additionally, some studies have suggested that vocabulary partially (Gottardo et al., 2018; Zhang, 2016) or fully (Goodwin et al., 2013) mediates the within-language associations between English morphology and English reading comprehension in bilinguals. The present study thus examines the contributions of both MA and vocabulary knowledge to English and Spanish reading comprehension.

Importantly, cross-linguistic comparisons suggest that morphological awareness in English may be slower to develop than in languages with a more predictable morpho-phonological structure (e.g., French; Duncan et al., 2009). It is therefore possible that children's bilingual experience with derivationally-rich Spanish may affect their sensitivity to specific morphemic structures (Kuo et al., 2017), influencing English reading. By studying bilingual learners, we may gain insight into the relations between spoken language experience, MA, and learning to read across languages.

Bilingual literacy and theories of cross-linguistic transfer

Theoretical models of reading comprehension have generally been limited to understanding a single language at a time. We must therefore ask whether the models informed by monolinguals also fully capture the nuances of bilingual reading comprehension.

Theories of bilingualism posit that a child's two languages are developmentally interconnected. A bilingual's two languages interact behaviorally and in the brain, influencing each other at multiple levels of word processing (Chung et al., 2019). There is increasing evidence for language interdependence in cognitive and metalinguistic skills (e.g., Sierens et al., 2019, 2021). For instance, a study of Spanish-English bilingual kindergarteners revealed an underlying general ability that explains oral language skills in both languages (LAARC et al., 2018). In the domain of oral narrative, story macrostructure is closely across a bilingual's two languages, extending beyond language-specific skills (Rodina, 2016; Otwinowska et al., 2018).

Regarding bilingual literacy development, the classic linguistic interdependence hypothesis (Cummins, 1979) suggests that bilingual children's second-language (L2) literacy development is inextricably tied to their literacy development in their native language (L1). Specifically, L1 may impact literacy in L2 through linguistic *transfer*: the process by which specific academic competencies in one language support developing skills in the other language (Cummins, 1979). More recent theoretical developments suggest that the nature of bilingual transfer varies based on numerous factors, including the specific metalinguistic skill in question, the distance between a child's languages, and their relative proficiency in each (Interactive Transfer Framework; Chung et al., 2019). Similarly, the Interdependence Continuum Model suggests that transfer is most likely at points of similarity between two languages, allowing a child to draw upon skills mastered in one language to support reading development in the other (Proctor et al., 2010).

Some skills, such as phonological awareness, are thought to be language-general, and likely to transfer between most language pairings (Chung et al., 2019; Marks et al., 2022). A child's knowledge of morphology, however, depends largely on their lexical knowledge and understanding of word structure in a given language and may not transfer as readily to support literacy across languages. For instance, a study of Spanish-speaking English learners in 4th grade found no evidence that either Spanish or English morphology contributed to literacy in the other language (Goodwin et al., 2015). In a different sample of 4th and 7th grade English learners, Spanish MA explained variance in English word reading, but not vice versa (Ramírez et al., 2010). To our knowledge, there is no evidence to date of a

bidirectional association wherein English MA – which is relatively less rich than Spanish morphology – explains variance in Spanish word reading.

Nevertheless, there are compelling reasons to predict that morphological awareness may have a cross-linguistic effect on reading among Spanish-English bilinguals. There are many shared cognates between English and Spanish (e.g., creation/*creación*; family/*familia*), and this point of linguistic contact may facilitate transfer. Indeed, Spanish vocabulary knowledge and cognate recognition have both been linked to English reading comprehension among English learners (Proctor et al., 2006; Ramírez et al., 2013). However, it is not clear whether this association is bidirectional. The present study aims to shed new light on bilingual literacy transfer, extending the prior work with English learners to a sample of simultaneous bilinguals with relatively balanced proficiency in English and Spanish, educated in the United States.

The present study

The current study aims to uncover cross-linguistic and bilingual effects on literacy development and bilingualism by asking two interrelated research questions. First, do the strength of Spanish-English bilingual children's within-language associations between MA, word reading, and reading comprehension differ across languages? Guided by Psycholinguistic Grain Size Theory (Ziegler & Goswami, 2005) and monolingual English evidence (e.g., Deacon et al., 2014), we predict that in English, MA will contribute directly to word reading, and both directly and indirectly to reading comprehension. In Spanish, we explore two competing predictions. On one hand, PGST suggests that in Spanish, sound-to-letter mapping may be largely sufficient for word reading. As such, MA might be necessary for successful comprehension, but not essential for word recognition. We therefore might observe only a direct contribution of morphology to reading comprehension. On the other hand, morphology might contribute to reading at the single word level as well, perhaps to facilitate the recognition of polymorphemic Spanish words (Antzaka et al., 2021).

Our second question asks about the cross-linguistic associations between morphology and literacy skills in English and Spanish. Specifically, do MA and word reading skills in Spanish support reading outcomes in English, and vice versa? Theories of cross-linguistic transfer (Chung et al., 2019) suggest that a bilingual's two languages are developmentally *interdependent;* as such, it may be insufficient to model the associations between literacy skills in only one language within a bilingual child's reading system. We address this question by fitting two structural equation models, both with and without cross-language paths. First we predict that models of bilingual reading will be substantially improved by allowing for bidirectional, cross-linguistic influences of each language on reading comprehension in the other. Furthermore, we predict that we will observe significant associations between MA and other-language word reading, and between word reading and other-language reading comprehension. Research has suggested that Spanish MA may transfer to bolster English literacy in Spanish-dominant bilinguals who are new to English, but has not found support for transfer in the opposite direction, from English to Spanish (Curinga, 2014). Here, we explore the possibility of more pronounced bidirectional associations in children with high dual-language proficiency. Guided by the Interactive

Transfer Framework (Chung et al., 2019), we extend prior literature by utilizing parallel measures in English and Spanish to examine bidirectional within- and between-language associations in a novel sample of dual first-language learners.

Materials & Methods

Ninety Spanish-English bilingual children ages 6–10 (43 boys, 47 girls) living in the Midwestern United States were included in our study. Participants were an average of 8.07 years old (*SD* = 1.38). All participants identified as Hispanic or Latinx per parent report, and eight additionally identified as white. All participants grew up in Spanish-speaking homes and attended English-only schools.

Measures

Participants completed parallel assessments in Spanish and English. These tasks were administered one-on-one in our lab by a native speaker of each language while parents completed a questionnaire detailing their child's language and literacy experience. The order of Spanish and English testing was randomized.

Vocabulary.—Vocabulary was assessed with Test de Vocabulario en Imágenes Peabody (TVIP; L. M. Dunn, et al., 1986) and the Peabody Picture Vocabulary Test (PPVT-5; Dunn, 2018). Participants were shown four images and asked to choose the image that best corresponds to a vocabulary word presented orally by the experimenter. Participants were only eligible for the current study if they had vocabulary within the typical range (standard score ≥85) in at least one of their languages.

Phonological awareness (PA).—Phonology was assessed using the Elision subtests of the Test of Phonological Processing in Spanish (TOPPS; August et al., 2001) and the Comprehensive Test of Phonological Processing in English (CTOPP-2; Wagner, et al., 2013). These tasks are entirely oral, and ask participants to say a word without a designated sound (i.e., "Say *time* without saying /*m*/). In models of bilingual reading comprehension, raw scores on TOPPS and CTOPP were summed to create a language-general composite PA score.

Reading.—Word reading and reading comprehension were assessed using the Letter Word Identification and Passage Comprehension subtests of the Batería III Woodcock-Muñoz (Muñoz-Sandoval et al., 2009), and the Woodcock-Johnson IV Tests of Achievement (Schrank, Mather, & McGrew, 2014). The letter word identification task requires children to read single words aloud. The passage comprehension task requires children to read connected text with one word missing and fill in the blank, such as "The sign by the building said 'No Parking.' It was not a place that you could leave your ___" [car].

Morphological awareness (MA).—Children completed experimenter-designed measures of MA in each language. Our MA measures specifically tap into children's *implicit* morphological awareness, sometimes called "morphological knowledge" (Apel, 2014). In keeping with the majority of prior literature however (e.g., Carlisle, 2004), we use the term "morphological awareness" throughout.

The Early Lexical Morphology Measure (ELMM) in English asked children to complete a sentence by extracting the root of a polymorphemic word, e.g., "*Quickly*. That lion was really ___ [*quick*]". This task was entirely oral to ensure it was accessible to all participants. Trained experimenters told children, "I am going to give you a word, and you are going to use part of that word to help me finish my sentence." Experimenters then administered items asking children to extract a root morpheme from either a compound (i.e., *classroom – room*) or derived polymorphemic word (i.e., *colorful – color*). This measure thus assessed children's sensitivity to compound and derivational lexical morphology, not inflectional morphology. Children received 1 point for each correct response. ELMM includes 40 items with high internal consistency (α = .93). Raw scores ranged from 3–40 (M = 24.10, SD = 10.90), and were highly correlated with English vocabulary (r = .78) and reading comprehension (r = .79). See Marks et al (2021, under review) for additional measurement details.

The parallel Early Lexical Morphology Measure - Spanish (ELMM-S) similarly asked children to complete a sentence, e.g., "*Claramente.* La explicación fue ____" [clara]. Like the English measure, this task assessed sensitivity to Spanish compound and derivational lexical morphology. Children received 1 point for a correct response, 0.5 points for extracting the correct root but with an incorrect gender marker (e.g., *claro*), and 0 points for an entirely incorrect response. The task included 50 items with high internal consistency (α = .95). Raw scores ranged widely from 0–47 (M = 23.51, SD = 11.07), and demonstrated high bivariate Pearson correlations with Spanish vocabulary (r = .79) and reading comprehension (r = .74).

Data analysis

We used structural equation modeling to test the predicted associations between language and literacy skills within and between languages. Our model included 9 variables. Per Kline's (2015) recommendation, an adequate sample size for path analysis is 10 times the number of variables in the model, suggesting that our sample of N = 90 was adequate for our investigation. Analyses were conducted in MPlus Version 8.5 (Muthén & Muthén, 2017) using a maximum likelihood (ML) estimator. First, we tested a within-language multiple mediation path model to predict Spanish and English reading comprehension. Second, we tested whether model fit improved when we opened cross-linguistic paths between MA, word reading, and reading comprehension. Models were compared using the χ^2 statistic, and goodness-of-fit was evaluated based on criteria from Kline (2015): Comparative Fit Index (CFI) > .95, Tucker Lewis Index (TLI) > .95, Standardized Root Mean Square Residual (SRMR) < .08, and Root Mean Square Error of Approximation (RMSEA) < .06.

Results

Bilingual language use and proficiency

Table 1 presents participant demographics and Table 2 presents descriptive statistics for all language and literacy measures are presented in Table 2. Children's Spanish and English language fell within the typical developmental range on all standardized assessments.

Participants began speaking Spanish significantly earlier than English: children uttered their first word in Spanish between 9 months and 1.5 years of age (M = 1.57 on a 6 point scale), and in English between 1.5 - 2.5 years of age (M = 3.19, $t(68) = -6.02$, $p < .001$). Most children began attending English-speaking schools in kindergarten or earlier (Table 1). Children thus had early and systematic exposure to both of their languages.

At the time of testing, all participants were enrolled in English-only schools. English was therefore participants' primary language of literacy. Fourteen (15.6%) children received some formal Spanish instruction, typically under 4 hours per week. Additionally, 56 (62.2%) parents reported that they were teaching their child to read in Spanish at home, while only 12 (13.3%) indicated that their child was not learning to read in Spanish (10 missing).

Modeling bilingual reading skills

We fit three path models to examine the interrelations between MA, PA, vocabulary, word reading, and reading comprehension in English and Spanish, controlling for grade (Figure 1). Given theoretical perspectives suggesting that phonology may be a language-general construct in bilinguals (Chung et al., 2019), and the high correlation between phonological awareness across languages, this was operationalized as a composite score. All other observed variables were language-specific. Informed by prior work, we regressed PA and MA on single word reading (e.g., Deacon & Kirby, 2004). We modeled a direct path between morphological awareness and reading comprehension, as well as indirect paths mediated by word reading (Deacon et al., 2014) and vocabulary knowledge (Goodwin et al., 2013).

In Model A (the "within language" model), we estimated paths between MA, vocabulary, and reading scores in each language. Except for the language-general PA construct, cross-language paths were constrained. This model was a good fit for our data ($\chi^2(16) = 22.78$, $p = .120$; see Table 3). Notably, we observed cross-linguistic differences in the associations between morphology, vocabulary, and reading comprehension across languages. In English, MA and word reading were significant predictors of reading comprehension, while vocabulary was not ($\beta = .14$, $p = .105$). In Spanish, MA had an indirect effect on reading comprehension through both word reading ($\beta = .21$, $p < .001$) and vocabulary knowledge ($\beta = .11$, $p = .007$), while the direct association between MA and reading comprehension was not significant ($\beta = .07$, $p = .268$).

In Model B (the "cross-linguistic" model), we opened cross-language paths between MA and word reading, and between word reading and reading comprehension. Informed by prior work with a similar sample (Wagley et al., 2022), we also opened a path from Spanish to English reading comprehension. Allowing for cross-linguistic influence significantly improved model fit, $\chi^2_{diff}(4) = 13.16$, $p = .011$. The direct effects between MA and word reading across languages were not significant, but we observed significant associations between English word reading and Spanish reading comprehension ($\beta = .24$, $p = .002$), and between Spanish and English reading comprehension ($\beta = .25$, $p = .037$). English morphology had an indirect effect on Spanish reading comprehension through English word reading ($\beta = .06$, $p = .032$).

Finally, in Model C (an alternate cross-linguistic model), we reversed one path and modeled the direct effect of English reading comprehension on Spanish reading comprehension. Model C also fit the data better than Model A $\chi^2_{diff}(4) = 11.41$ $p = .022$, and was not significantly different from Model B (Table 3). However, the direct effects of English word reading ($\beta = .13$, $p = .179$) and English reading comprehension ($\beta = .15$, $p = .113$) on Spanish reading comprehension were not significant. Model B had an AIC statistic of 1.75 units lower than Model C, just under the commonly used heuristic that a model is significantly improved if its AIC statistic is at least 2 units lower than the comparison (Burnham & Anderson, 2004). Because Model B is more closely aligned with theoretical perspectives suggesting transfer from a child's first-acquired language to their primary language of literacy (Cummins, 1979), we consider Model B to be the final model.

Discussion

This study examined the relations between morphological awareness and literacy in Spanish-English dual first-language learners. First, our findings reveal language-specific differences in the associations between MA, word reading, and reading comprehension within English and Spanish. Second, we provide evidence for positive, bidirectional associations between literacy skills across languages. These findings contribute to the body of theoretical evidence indicating that a child's heritage language is a positive resource for learning to read.

Morphological awareness and English reading

Our first question focused on within-language associations between MA and literacy. Consistent with prior work, we found that MA in English made a direct contribution to reading comprehension, as well as an indirect contribution through English word reading (Deacon et al., 2014; Kieffer & Box, 2013). In contrast, we found no direct contribution of vocabulary to reading comprehension. This finding is consistent with a study of 3rd graders that demonstrated an effect of MA on vocabulary knowledge, but no effect of vocabulary knowledge on reading comprehension (Levesque et al., 2017). However, it contrasts with prior studies with older monolingual readers in 6th grade and above (Kieffer & Box, 2013; Kieffer & Lesaux, 2012a), as well as emerging bilingual readers learning English (Goodwin et al., 2013; Zhang, 2016). This discrepancy is likely due to differences in age and English proficiency across studies. Nevertheless, the roles of MA and vocabulary knowledge across development warrant further investigation.

Morphological awareness and Spanish reading

We had two competing predictions regarding the role of morphology in Spanish word reading. In line with PGST (Ziegler & Goswami, 2005), our first prediction was that MA would not make a substantial contribution to word reading above and beyond PA, due to the transparency of sound-to-print mappings in Spanish. Yet given the rich morphology and orthographic regularity of Spanish, we also thought it possible that morphology might facilitate Spanish word reading, particularly for recognizing long, polymorphemic words.

Akin to English, we observed a significant direct effect of Spanish MA on Spanish reading comprehension. This finding is consistent with our second prediction: MA contributes

to word reading in opaque as well as phonologically transparent orthographies, likely facilitating the orthographic and semantic recognition of polymorphemic words (Antzaka et al., 2021). In contrast to English, however, we found that Spanish MA did *not* make a direct contribution to Spanish reading comprehension. Instead, this association was fully mediated by Spanish word reading and vocabulary knowledge, replicating findings from Oliveira and colleagues (2020) in monolingual Brazilian Portuguese-speaking 2nd graders. This full mediation contrasts prior work with monolingual Spanish-speaking 4th graders, which found no contribution of Spanish morphology to word reading and a direct association with reading comprehension (D'Alessio, Jaichenco, et al., 2019). These diverging results may stem from sample differences, and the fact that our participants are, on average, closer in age to Oliveira's (2020). Another possibility is that a small grain size may be sufficient for Spanish word recognition, making MA less essential at the word level. Nevertheless, our Spanish-English bilinguals may be applying their English reading strategies developed at school to their Spanish reading (Lallier & Carreiras, 2018).

Morphological awareness, vocabulary knowledge, and reading across languages

The unique roles of morphology and vocabulary are notoriously difficult to disentangle (Spencer et al., 2015). This interconnection is made increasingly complicated in studies of bilingual learners with lexical overlap between their two languages, such as Spanish and English. While some studies suggest that vocabularies across languages are relatively independent (e.g., Cobo-Lewis et al., 2002), others - particularly studies in which participants have high Spanish and English proficiency - reveal moderate correlations across languages (Kremin et al., 2016; Sun et al., 2021). Furthermore, there is evidence that knowledge of Latin cognates can support language and literacy across languages (Ramírez et al., 2013), particularly when students receive explicit strategy instruction (Dressler et al., 2011). Finally, bilingual transfer at the level of word processing can be further supported by the interconnection of the two languages at broader levels of language competence and generalized cognitive systems, such as narrative production, listening comprehension and meta-cognition (Sierens et al., 2019, 2021; Uccelli & Paez, 2007).

One notable yet puzzling finding in the current study is the cross-linguistic difference in the contributions of MA and vocabulary knowledge to reading. In our data, MA and reading comprehension are not directly associated in Spanish; rather, Spanish vocabulary mediates the contribution of morphology to reading comprehension. However, in English, MA contributes directly to English reading, while vocabulary does not. One possible explanation relates to the contexts of academic vocabulary development for the present sample. All participants were heritage speakers of Spanish; children likely received explicit academic vocabulary and/or morphological instruction in English through formal schooling, whereas their Spanish academic language is likely to be more limited. Perhaps deeper, more explicit knowledge of English morphology captures the variance in reading comprehension that could otherwise be accounted for by vocabulary, whereas the contribution of Spanish morphology may be relatively more constrained by Spanish vocabulary knowledge. Additional work with English learners, or English heritage speakers educated in Spanish may help to clarify these associations.

Cross-linguistic associations between literacy skills in English and Spanish

Our second research question asked about cross-linguistic associations between bilingual literacy skills. Theoretical perspectives suggest that a bilingual's two languages are developmentally *interdependent* (Chung et al., 2019; Cummins, 1979; Proctor et al., 2010). To test this theory, we compared structural equation models that did vs. did not allow for cross-language associations. Results suggested that although Model A (the "within language" model) fit our data well, opening cross-language paths in Model B significantly improved model fit.

We then examined the paths estimated between Spanish and English constructs. Guided by prior work with English learners (Curinga, 2014; Ramírez et al., 2010), we expected that Spanish MA might have a cross-linguistic effect on English word reading. Because our sample consists of simultaneous bilinguals with high proficiency in both languages, we also thought it possible that we might observe an effect of English morphology on Spanish reading. Neither of these paths were significant in Models B or C. In other words, contrary to our predictions, MA did not appear to have a direct cross-linguistic effect on reading. This null result may be in part because of the high covariance between MA in English and Spanish, and the variance captured by the shared PA construct.

We nevertheless observed significant cross-linguistic influences on reading comprehension in both languages. Model B revealed a positive direct effect of English word reading on Spanish reading comprehension. As all of our participants are primarily learning to read in English at school and generally have more limited Spanish reading instruction, this finding suggests that children can apply their formal literacy instruction to additionally support reading in Spanish. The findings are aligned with other bilingual research that demonstrates transfer from the language of reading instruction back to children's home language (Wang et al., 2006). Second, we observed a direct effect of Spanish reading comprehension on English reading comprehension. This finding replicates a recent discovery with a similar sample: Wagley and colleagues (2022) reported an effect of language-specific morphosyntactic knowledge on within-language word reading, as well as cross-linguistic effects of English word reading on Spanish reading comprehension, and Spanish reading comprehension on English reading comprehension.

Importantly, we also tested an alternate model in which the direction of the path between English and Spanish reading comprehension was reversed. Although the fit of Model C did not significantly differ from Model B, none of the cross-language paths remained significant predictors of reading comprehension in either language. Together, these findings thus help inform theories of bilingual literacy by demonstrating bidirectional bilingual transfer, with the more granular (word-level) literacy skills transferring from the language of schooling into the home language, and broader literacy skills (passage comprehension) transferring from the home language to English.

Situating findings with broader theories of reading comprehension

Our findings advance the Reading Systems Framework (Perfetti & Stafura, 2014) by modelling bilingual and cross-linguistic influences on reading comprehension, suggesting

that it is robust across languages and populations. We observed a direct effect of MA on word reading and an indirect effect on reading comprehension in both English and Spanish. At the same time, our findings suggest that the relative associations between elements of the lexicon (e.g., morphology and vocabulary knowledge) and reading comprehension may vary across languages. Perfetti and Stafura (2014) specify that "a particular point of focus [of the Reading Systems Framework] is the lexicon, which is a central connection point between the word identification system and the comprehension system" (p. 24). The present study advances our understanding of the universality of literacy theory by demonstrating cross-linguistic differences in the contribution of MA, and the lexicon more generally, to reading comprehension.

In addition to its relevance for reading comprehension, MA can be understood in relation to broader academic language skill development. Recent work examining the specific skills critical for developing the language of schooling (Snow & Uccelli, 2010) suggests that understanding and making connections between morphologically complex words is a Core Academic Language Skill (Barr, Uccelli & Phillips Galloway, 2019). When it comes to supporting linguistically diverse learners at school, it is critically important that children's home language competencies are viewed as resources that support academic development. Notably, recent work by Hernandez and colleagues suggests that while early English vocabulary is largely Germanic in origin, the academic vocabulary knowledge acquired in later childhood and adolescence is disproportionately Latinate (2021). Spanish-English bilingual proficiency, and the possibility of cross-linguistic transfer, may thus provide a promising means of supporting academic language development, and achievement beyond the literacy domain.

Limitations and future directions

A key element of this inquiry is the examination of proficient dual language speakers. Examining bilinguals with comparable and age-appropriate proficiency in both of their languages presents a unique opportunity to identify the effects of morphology while minimizing the confound of vocabulary. This sample of highly proficient biliterate readers does not reflect all bilingual learners. However, our findings are consistent with those of proficient monolingual readers, clarifying the role of morphology in bilingual and monolingual reading of phonologically transparent languages.

This study is limited by its use of a single morphology measure and a single vocabulary measure in each language. The present findings that vocabulary contributes directly to Spanish reading while MA does not (yet the opposite is true of English) raises many questions about the associations between morphology and vocabulary knowledge across languages. It is possible that this result is related to the specific measures used. However, a strength of the current study is the fact that measures were maximally matched across languages, lending credence to this somewhat puzzling result.

We also note that our sample includes children between 6 and 10 years old, a time of great developmental change and rapid literacy acquisition. We have controlled for grade level to partially account for differences in schooling experiences across participants. However, we recognize that this methodological choice may mask developmental differences.

Unfortunately, our sample is insufficiently large for us to reliably examine younger vs. older, or less vs. more proficient readers separately; this is an important direction for future work.

Conclusion

This study extended the Reading Systems Framework (Perfetti & Stafura, 2014) to bilingual readers. Our findings speak to the importance of MA for literacy across languages, and suggest a cross-linguistic difference in how morphology contributes to reading comprehension. We also provide evidence of bidirectional bilingual associations between word- and passage-level reading skills. These findings clarify the effects of home- and school-language transfer in the context of relatively balanced, age-appropriate dual-language proficiency, and support the value of heritage language maintenance for learning to read.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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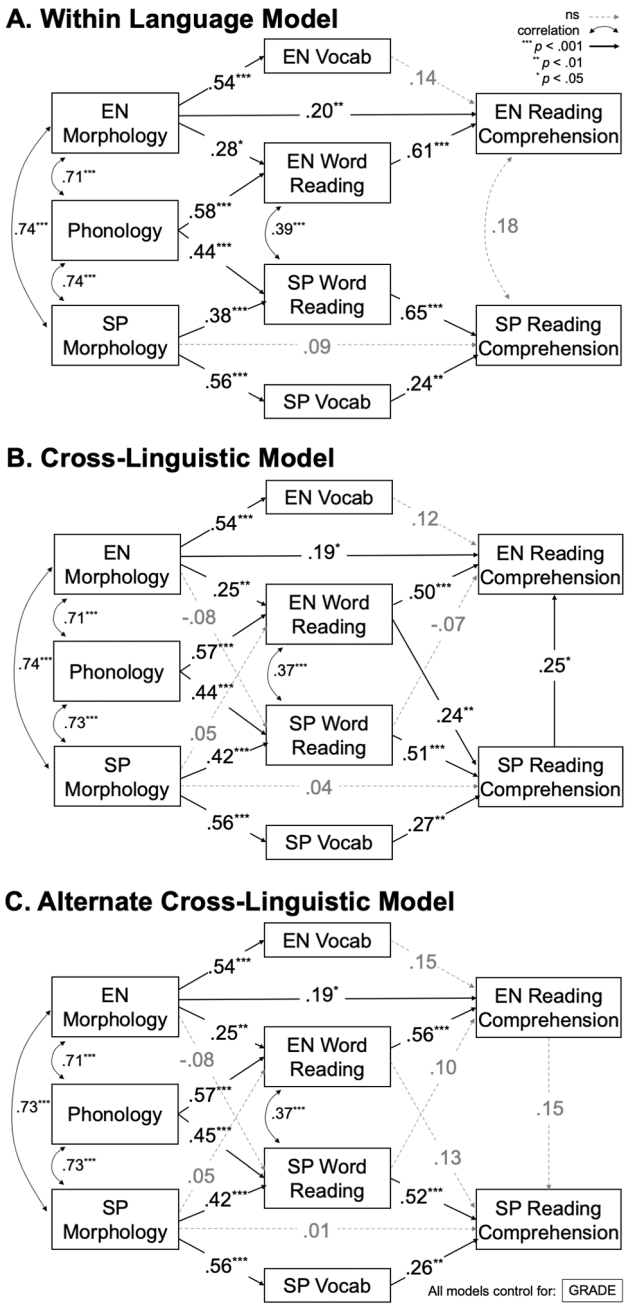

Figure 1. Structural Equations Models

Note. *$p < .05$, **$p < .01$, *** $p < .001$. Fit statistics are in Table 3. Model B fits the data best.

Table 1

Participant demographics

Demographic characteristic	*N*	*M (SD)*
Gender	90	
Girl	47	
Boy	43	
Grade	90	2.02 (1.51)
1. Kindergarten	18	
1. 1st grade	20	
2. 2nd grade	16	
3. 3rd grade	18	
4. 4th grade	14	
5. 5th grade	4	
Entry into English-speaking school	81	1.27 (0.61)
1. Preschool or earlier	65	
2. Kindergarten	11	
3. 1st grade	4	
4. 2nd grade	1	
Parent 1 country of origin	80	
Parent 2 country of origin	64	
Argentina	1	
Colombia	3	
Germany	1	
Guatemala	2	
India	1	
Mexico	125	
Peru	2	
Spain	2	
Venezuela	7	
Parent 1 educational attainment	88	4.59 (1.21)
Parent 2 educational attainment	75	4.41 (1.60)
1. Less than high school	14	
2. High school diploma/GED	7	
3. Associate degree	8	
4. Bachelor's degree	76	
5. Master's degree	46	
6. Doctoral degree	12	

Table indicating participants' gender, grade, age at which they began attending English-speaking school, and parental country of origin and educational attainment.

Table 2

Descriptive statistics, reliabilities, and Pearson correlations between Spanish and English measures

				Spanish									
	M	***SD***	**Reliability**	***1***	***2***	***3***	***4***	***5***					
1. SP vocabulary [a]	109.23	(16.53)	.86–.94 [c]	-									
2. SP word reading [a]	112.58	(23.50)	.95–.98 [c]	.72	-								
3. SP reading comprehension [a]	92.91	(18.56)	.84–.98 [c]	.77	.88	-							
4. SP phonological awareness [b]	66.07	(33.04)	.83 [c]	.64	.70	.67	-						
5. SP morphological awareness [b]	56.31	(26.91)	.95 [d]	.79	.73	.74	.74	-					
				Spanish					**English**				
	M	***SD***		***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
6. EN vocabulary [a]	101.36	(16.70)	.97 [c]	.75	.55	.62	.61	.63	-				
7. EN word reading [a]	109.01	(18.87)	.92–.98 [c]	.67	.76	.77	.81	.71	.74	-			
8. EN reading comprehension [a]	98.70	(13.00)	.81–.98 [c]	.69	.71	.76	.78	.76	.77	.88	-		
9. EN phonological awareness [b]	67.74	(25.10)	.86–.92 [c]	.56	.63	.61	.87	.68	.63	.83	.78	-	
10. EN morphological awareness [b]	60.26	(27.25)	.93 [d]	.68	.62	.59	.67	.73	.78	.76	.79	.69	-

Note.

[a] Standard score

[b] raw score, presented as percentage correct out of possible items.

[c] Reliability from manual in age range of study sample

[d] Cronbach's alpha from study sample. All correlations are significant at $p < .001$.

Table 3

Fit statistics and model comparison

Model	AIC	χ^2	df	*p*	CFI	TLI	RMSEA	SRMR
A. Within language	5688.93	22.78	16	.120	.99	.97	.07	.03
B. Cross-linguistic	5683.78	9.62	12	.649	1.00	1.00	.00	.02
C. Cross-linguistic (alternate)	5685.53	11.37	12	.497	1.00	1.00	.00	.02
Comparison $A - B$	5.15	13.16	4	.011				

Comparison of fit statistics across structural equations models.