Bilingual Research Journal
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t909204797

The Interdependence Continuum: A Perspective on the Nature of Spanish-English Bilingual Reading Comprehension

C. Patrick Proctor [a]; Diane August [b]; Catherine Snow [c];Christopher D. Barr [d]
[a] Boston College, [b] Center for Applied Linguistics, [c] Harvard Graduate School of Education, [d] University of Houston,

Online publication date: 27 April 2010

To cite this Article Proctor, C. Patrick , August, Diane , Snow, Catherine andBarr, Christopher D.(2010) 'The Interdependence Continuum: A Perspective on the Nature of Spanish-English Bilingual Reading Comprehension', Bilingual Research Journal, 33: 1, 5 — 20
To link to this Article: DOI: 10.1080/15235881003733209
URL: http://dx.doi.org/10.1080/15235881003733209

Bilingual Research Journal, 33: 5–20, 2010

ISSN: 1523-5882 print / 1523-5890 online
DOI: 10.1080/15235881003733209

Routledge
Taylor & Francis Group

RESEARCH ARTICLES

The Interdependence Continuum: A Perspective on the Nature of Spanish–English Bilingual Reading Comprehension

C. Patrick Proctor
Boston College

Diane August
Center for Applied Linguistics

Catherine Snow
Harvard Graduate School of Education

Christopher D. Barr
University of Houston

Dr. C. Patrick Proctor is Assistant Professor of Language and Literacy at the Boston College Lynch School of Education. His research focuses on children who speak first languages other than English, processes of cross-linguistic transfer, and the means by which transfer can be facilitated.

Diane August is Senior Research Scientist at the Center for Applied Linguistics in Washington, DC. She is Principal Investigator of a federally funded study investigating literacy development in English language learners, Co-Principal Investigator for a federally funded randomized evaluation of English-immersion and transitional bilingual programs, and Co-Principal Investigator at the National Research and Development Center on English Language Learners. She was Staff Director for the National Literacy Panel on Language Minority Children and Youth.

Catherine Snow is Patricia Albjerg Graham Professor at the Harvard Graduate School of Education. A former president of the American Educational Research Association, she is involved in experimental evaluations of programs designed to improve the language and literacy skills of prekindergarten and kindergarten children in Chile and of middle schoolers in U.S. urban districts.

Christopher D. Barr, PhD, is Assistant Research Professor for the Texas Institute for Measurement, Evaluation, and Statistics at the University of Houston. His research interests include application of multilevel and latent variable modeling techniques for studying nested data structures, especially in the area of performance and feedback.

Address correspondence to C. Patrick Proctor, Boston College, Lynch School of Education, 140 Commonwealth Ave., Chestnut Hill, MA 02467. E-mail: proctoch@bc.edu

The purpose of the current study is to elaborate on the statistical nature of the linguistic interdependence hypothesis (Cummins, 1979). It is argued that reading skills across the languages of bilingual learners are differentially robust to interdependence, falling along a continuum mediated by the commonalities between Spanish and English. Reading data were collected from a sample of 91 Spanish–English bilingual fourth-grade students, and structural equation modeling was used to test a path model of the interdependence continuum. The model assumed that Spanish–English interdependence would be strong for alphabetic knowledge, moderate for reading comprehension, and mild for the link between Spanish oral language and English reading comprehension. The model fit the data well, providing some initial evidence for an interdependence continuum that varies as a function of language typology.

INTRODUCTION

The education of English language learners (ELLs), particularly the facility with which they acquire English and apply that proficiency in academic settings, has fueled interest and debate for decades. Notably, the concept of cross-linguistic transfer has been widely deployed as a rationale for providing native language instruction to English-learning children (Snow, 1992). Most readers familiar with the literature in this area have become conversant with Cummins's (1979, 1991) Linguistic Interdependence hypothesis, which posits that well-developed native language (L1) skills are likely to transfer to a learner's second language (L2), thereby improving educational outcomes for ELLs. Cummins's groundbreaking conceptualization of transfer has inspired an impressive amount of empirical research, which continues to demonstrate that bilingual learners with well-developed L1 language and literacy skills are more likely to acquire their L2 to higher levels (Dressler & Kamil, 2006; Genessee & Geva, 2006).

The search for transfer has produced some intriguing findings, most of which tend to focus on associations across analogue L1 and L2 language and literacy skills, or between L1 language proficiency and L2 reading comprehension. Far less common are holistic models of bilingual reading comprehension that combine these two perspectives on transfer and incorporate a range of language and literacy variables in both the L1 and L2 to model bilingual reading comprehension. Such is the purpose of the current research.

CROSS-LINGUISTIC TRANSFER

In his classic paper, Cummins (1979) outlines vocabulary-concept knowledge, metalinguistic insights, and decontextualized language as the primary language components necessary for successful school literacy development. If a child is able, in the L1, to use language to represent an understanding of various concepts (vocabulary-concept knowledge), grasps the notion that print has meaning and that writing differs from speech (metalinguistic insights), and is able to use and understand language to represent abstract, complex thoughts and ideas (decontextualized language), then there is sufficient foundation for the development of strong L1 literacy outcomes, which are hypothesized to correlate with L2 language and literacy achievement.

In the years since, a good deal of research has been devoted to exploring Linguistic Interdependence. Dressler and Kamil (2006) reviewed the research and found that the most common of these studies focused on three domains: (a) alphabetic and word-level knowledge, (b) oral

language/vocabulary knowledge, and (c) reading comprehension. Snow and Kim (2006) locate these and other literacy outcomes along a continuum of "problem spaces" that are implicated in development, teaching, and learning. The size of the problem space is associated with the degree of the learning challenge (assuming relatively typical development). Snow and Kim (2006) argue that alphabetic and word-level knowledge inhabit a relatively small problem space while constructs such as oral language/vocabulary and meaning making (i.e., comprehension) occupy larger spaces that require more intensive instruction over longer periods of time. We contend that the size of the problem space is also associated with the degree to which cross-linguistic associations are likely to manifest. Specifically, smaller problem spaces present greater opportunities for cross-linguistic association while the larger spaces are inherently less robust given the broader range of knowledge required for mastery of the domain. Within this context, we next consider cross-linguistic relations among the three constructs identified above.

Alphabetic and Word-Level Knowledge

The most abundant and robust cross-linguistic findings are typically found in this relatively small problem space. By and large, these studies are correlational and find that decoding skills such as alphabetic knowledge (Verhoeven, 1994) and word reading (DaFortuna and Siegel, 1995; Durgunoglu, Nagy, & Hancin-Bhatt, 1993; Gholmain & Geva, 1999) are particularly robust to cross-linguistic correlation, especially when the two languages in questions are orthographically comparable.

Bialystok, Luk, and Kwan (2005) characterized the phenomenon well. The authors administered pseudoword reading tasks to four groups of first graders: English monolinguals, Spanish–English bilinguals, Hebrew–English bilinguals, and Chinese–English bilinguals. Bialystok and colleagues (2005) used correlational data to demonstrate how cross-language associations varied among the three orthographic contrasts (Spanish–English, Hebrew–English, Chinese–English). Correlations between L1 and L2 alphabetic knowledge were greatest for Spanish–English bilinguals (very common orthographies; $r = .73$, $p < .01$), moderate for Hebrew–English bilinguals (both alphabetic languages; $r = .57$, $p < .01$), and low for Chinese–English bilinguals (no common orthography; $r = -.10$, ns).

In more causal work, Cirino and colleagues (2009) explicitly tested for the existence of cross-linguistic transfer in their 1-year follow-up study of a group of 215 Spanish–English bilingual learners who had received a Spanish or English reading intervention in the first grade (depending on their language of initial reading instruction). Gains were maintained in Spanish for the Spanish group and English for the English group. The authors assessed whether the Spanish intervention students outperformed their Spanish-speaking control counterparts on English measures, finding mild, but significant group differences for word reading ($d = 0.36$).

Oral Language/Vocabulary Knowledge

Very few studies find evidence of transfer between the very large problem space occupied by language skills that are most often operationalized with measures of expressive or receptive vocabulary knowledge (Gennesse & Geva, 2006). Indeed, more studies show negative correlations between L1 and L2 language proficiency. Ordóñez, Carlo, Snow, and McLaughlin (2002), for example, reported a −.22 correlation between Spanish and English receptive vocabulary

among upper-elementary Spanish–English bilinguals and Carlisle, Beeman, Davis, and Spharim (1999) reported a −.03 correlation between for this construct among Spanish–English bilinguals attending first, second, and third grade. Some research has identified evidence of interdependence among reading vocabulary measures that tap Spanish–English cognate awareness (e.g., Proctor & Mo, 2009; Nagy, García, Durgunoglu, & Hancin-Bhatt, 1993; Hancin-Bhatt & Nagy, 1994; Jiménez, García, & Pearson, 1996), but interdependence of L1 and L2 oral-language proficiency appears to be limited.

Genessee and Geva (2006) did, however, find some evidence for associations between L1 oral language and L2 reading comprehension. Dufva and Voeten (1999), working with Finnish adolescents, found a distal effect of L1 (Finnish) language proficiency and L2 (English) reading comprehension in their assessment of Finnish–English interdependence. Similarly, Proctor, August, Carlo, and Snow (2006) found that, among fourth-grade U.S. Spanish–English bilinguals, Spanish expressive vocabulary knowledge predicted English reading comprehension only on control for English language and literacy skills (i.e., listening comprehension, alphabetic knowledge, and fluency). The cross-linguistic relationships involving this construct are arguably less tenable due to the wide variability of language proficiency in the problem space.

Reading Comprehension

Studies examining the very large space of reading comprehension are less common, but, interestingly, demonstrate positive and significant associations that tend to be lower than for word-level skills. Lee and Schallert (1997), testing Cummins's (1979) threshold hypothesis, administered a measure of L2 oral language proficiency (including synonyms, antonyms, definitions, and analogies) to a group of 809 Korean–English bilingual students. For students with stronger L2 oral-language skills, larger cross-linguistic correlations were noted, ranging from .34 to .47. Schoonen, Hulstijn, and Bossers (1998) worked with Dutch 8th and 10th graders who were learning English and noted strong correlations between reading comprehension in Dutch and English (.61 for 8th graders, .62 for 10th graders). Finally, Nagy, McClure, and Mir (1997) studied the nature of syntactic transfer in Spanish–English 7th- and 8th-grade bilingual students and found a .69 association between Spanish and English reading comprehension.

Of note in these studies is that orthography did not appear to affect cross-linguistic associations, distinguishing linguistic interdependence in reading comprehension from alphabetic knowledge. Coady (1997) suggests that transfer at the comprehension level, despite the size of the space, is more likely mediated by improving L2 comprehension. As comprehension in the second language improves, the reader is more readily able to employ a-linguistic strategies, already developed in the L1, to make greater sense of L2 texts.

A MODEL OF SPANISH–ENGLISH READING

English and Spanish are orthographically and typologically comparable and resemble one another in terms of the developmental reading skills that predict comprehension (Pollard-Durodola, Mathes, Cárdenas-Hagan, Linan-Thompson, & Vaughn, 2006), which augurs for the increased likelihood of cross-linguistic transfer, especially when instruction in both languages is present (García, Kleifgen, & Falchi, 2008). Given the theoretical considerations outlined above, Figure 1

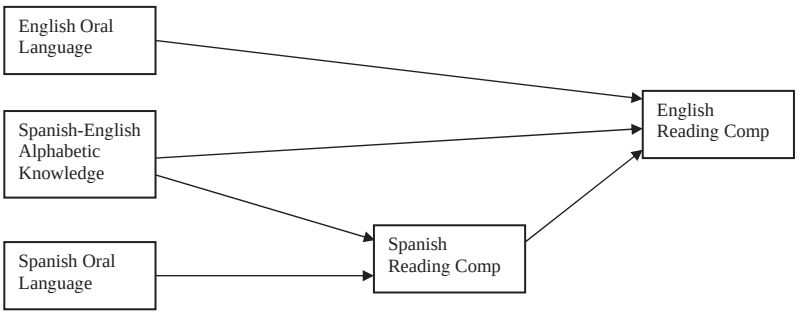

FIGURE 1 Theory-driven path model predicting both Spanish and English reading comprehension within a single model.

details a model of Spanish–English reading comprehension that portrays the three constructs previously described (i.e., alphabetic knowledge, oral language/vocabulary knowledge, and reading comprehension) in a holistic model of reading comprehension that also locates these L1 and L2 skills on a Spanish–English interdependence continuum.

Given the graphemic correspondences between Spanish and English, alphabetic knowledge is represented as a common skill that combines Spanish and English. Spanish and English oral language proficiency are directly predictive of reading comprehension in their respective anguages. However, as the literature suggests, Spanish reading comprehension is predicted to maintain a proximal relationship with English reading comprehension, thus establishing a distal link between Spanish oral-language proficiency and English reading comprehension.

SITUATING THE CURRENT RESEARCH

Empirically, we situate the current study in a continuing line of inquiry that began with an examination of the English reading comprehension of Spanish–English bilingual fourth graders (Proctor, Carlo, August, & Snow, 2005), and went on to explore the effects of Spanish language and literacy skills on the English reading of those students (Proctor, August, Carlo, & Snow, 2006). Working with a sample of 135 Spanish–English bilingual fourth graders, we found that English oral-language skills, including vocabulary knowledge and listening comprehension, were strongly predictive of bilingual students' English reading comprehension. Adding Spanish literacy variables (word reading, fluency, vocabulary knowledge, and listening comprehension) to the regression model showed that Spanish vocabulary knowledge was significantly predictive of English reading comprehension, particularly for students who possessed average to high levels of English fluency. However, these cross-linguistic predictors only explained an additional 2% of variation in English reading comprehension. The current research seeks to build on those findings by considering the reading process of bilingual learners as inclusive of the entire host of Spanish and English literacy skills working concomitantly, rather than simply testing individual L1 skills' effects on English reading comprehension.

Theoretically, we situate this study in the larger conversation about biliteracy among researchers and practitioners. Specifically, Hornberger (1989, 2004) outlines the Continua Model

of biliteracy, which "uses the notion of intersecting and nested continua to demonstrate the multiple and complex interrelationships between bilingualism and literacy" (Hornberger, 2004, p. 156). The model is comprised of four distinctive biliteracy domains: Context, Development, Content, and Media. Each of these domains is characterized by three intersecting continua. First, Context is characterized by the macro–micro, the oral–literate, and the bi(multi)lingual–monolingual continua. Development is comprised of the production–reception, oral–written, and L1–L2 continua. Content includes minority–majority, vernacular–literary, and contextualized–decontextualized. Finally, Media is characterized by the exposure (successive–simultaneous), structure (similar–dissimilar), and script (divergent–convergent) continua.

The Continua Model can be used as a framework for characterizing research across methodological approaches. For example, the focus of the current work falls along the oral–literate continua that characterize both the Context and Development domains. In this study, we are interested in how Spanish and English oral language and literacy skills work in concert to predict reading comprehension in both languages. The Content domain can be characterized along the minority–majority and contextualized–decontextualized continua. We are investigating the reading process for students who are literate in a majority (English) and minority (Spanish) language, yet we use highly decontextualized measures to operationalize our constructs of the bilingual reading process. Finally, the Media domain can be characterized by both the exposure (simultaneous–successive) and structure (similar–dissimilar) continua. The students in the study were acquiring language and literacy in Spanish and English both at home and at school. Some had learned Spanish and English successively, while others acquired both languages simultaneously. Finally, as previously discussed, Spanish and English are highly similar in structure, which is crucial for theorizing an interdependence continuum.

METHOD

Participants

The participants were 91 Spanish–English bilingual fourth-grade students (average age = 10 years, 1 month) from three large elementary schools in Boston, MA (n = 29), Chicago, IL (n = 30), and El Paso, TX (n = 32). Data were collected in the 3rd year (fourth grade) of a 4-year longitudinal study on bilingual and biliterate development in native Spanish-speaking children. The current research takes a cross-sectional, not a longitudinal, perspective on the reading process for the participating students at the time data were collected in the Spring of Year 3 of the larger study (2000–2001 school year).

In the first year of the project, when the students were in second grade, parents across all three schools were sent permission forms with the hope of full participation. Students were included in the project if their parents consented to their participation and if they did not have a learning disability. In Year 1, the total sample size was 193. In Year 2, that original group had been reduced to 156 due to attrition typical of longitudinal studies. To account for this attrition, 47 students who were newly matriculated in the schools were added to the overall sample (n = 203). In Year 3, the year under study in the current research, another 63 students were lost due to attrition, and 47 newly matriculated students were added to the sample (n = 187). While these new additions to the sample would be excluded from the longitudinal dataset, their inclusion for the

current cross-sectional research resulted in a larger sample size, which increased the overall power of the analyses. Of the 187 fourth-grade students, 91 had received or were receiving literacy instruction in Spanish (in addition to English) while the remainder (n = 96) had received only English instruction. For the purposes of the current research, we were interested exclusively in students who displayed a biliterate profile, and thus excluded from analysis those 96 students who never received Spanish literacy instruction. All 91 of the participants received Spanish literacy instruction via *Éxito para todos*, the Spanish-language version of *Success for All* (see Slavin, Madden, Dolan, & Wasik, 1996 for instructional details).

As is evident in Table 1, the schools the children attended were relatively homogenous institutions with large percentages of Latina/o students from low socioeconomic backgrounds, many of whom were designated as ELL. Further, the cultural and linguistic variation among the students was considerable and site dependent. Most children at the Boston site, for example, hailed from the Caribbean, with links to the Dominican Republic and Puerto Rico. By contrast, children in El Paso and Chicago were predominantly of Mexican origin.

Additionally, levels of education of the parents were skewed to higher values. Eighty-two percent of the students' mothers and 73 percent of the students' fathers reported completing high school or elementary school, with the remainder reporting some college or postgraduate work. Further, the students hailed from Spanish-dominant households. Approximately half the students came from homes where only Spanish was spoken (48%). Twenty-one percent reported that Spanish was used most of the time, while 21 percent reported that both languages were used in the home. Only seven parents reported mostly or only English being spoken in the home.

Based on Figure 2, a series of standard print and computer-based language and literacy measures were administered to assess Spanish and English literacy skills. Principal components analysis with varimax rotation was used to create theory-driven latent variables resulting in constructs of Spanish oral-language (vocabulary knowledge and listening comprehension in Spanish), English oral-language (vocabulary knowledge and listening comprehension in English), and Spanish–English alphabetic knowledge (alphabetic knowledge in Spanish and English). We then established a covariance matrix consisting of the three latent variables and two observed variables (Spanish reading comprehension, English reading comprehension) and used LISREL structural equation modeling to assess the fit of the model.

Measures

The Computer-based Academic Assessment System (CAAS; Sinatra & Royer, 1993) was used to measure a degree of mastery of alphabetic knowledge in Spanish and English. A latent variable was derived from a principal components analysis of the English and Spanish alphabetic know-

TABLE 1
Demographic and Socioeconomic Indicators for Participating Schools

School Site	*Total Enrollment*	*% LEP*	*% Free and Reduced Lunch*	*% Anglo*	*% African American*	*% Latino*	*% Asian*
Boston	741	48.3	87.9	3.5	19.4	76.1	0.7
Chicago	943	53.0	99.0	3.8	7.1	89.1	0.0
El Paso	642	69.2	74.8	0.5	0	99.3	0.0

ledge measure as a general factor of decoding skill. Next, the Woodcock Language Proficiency Battery (Woodcock, 1991) and the Woodcock-Muñoz (Woodcock & Muñoz-Sandoval, 1995) were used to measure the variables that would comprise the oral-language factor for Spanish and English (i.e., vocabulary knowledge and listening comprehension). Finally, Spanish and English reading comprehension were also assessed with the Woodcock Language Proficiency Battery and the Woodcock-Muñoz. Native speakers of English and Spanish administered the tests individually in settings outside the classroom to minimize distractions. The measures are described below.

Spanish and English Alphabetic Knowledge

A computer-administered test of pseudoword recognition was used as an indicator of a reader's alphabetic knowledge in Spanish and English. The computer displayed a single pronounceable pseudoword (derived from real Spanish and English words, by altering one letter in each real word) to the student, who read it, using the phonological and orthographic conventions of Spanish or English, into a microphone. The examiner then evaluated the student's answer as correct or incorrect. In both languages, this pseudoword task was comprised of 240 possible items (60 three-, four-, five-, or six-letter pseudowords). Of these, 40 words were presented to the student (10 words for each level) in random order (Cisero, Royer, Marchant, & Jackson, 1997). Descriptive output is reported as a percentage of correctly pronounced items. In Spanish, the test–retest reliability from Grade 3 to Grade 4 was .84. In English the test–retest reliability was .51.

Spanish and English Vocabulary Knowledge

The Woodcock (1991) Picture Vocabulary (*Vocabulario Sobre Dibujos*) test was used to assess children's vocabulary knowledge in English and Spanish. This measure required the student to name both "familiar and unfamiliar pictured objects" (Woodcock, 1991, p. 10), ordered by increasing difficulty, with each response scored as correct or incorrect by the examiner. Descriptive output is presented in both raw score and grade-equivalent form. Raw scores were used for all analyses. The test–retest reliability was reported by the test authors as .75 in Spanish and .86 in English.

Spanish and English Listening Comprehension

The Woodcock Listening Comprehension (*Comprensión de Oraciones*) test was used to assess participants' listening comprehension skills in both languages. This is a cloze assessment where the student listened to tape-recorded passages in order of increasing difficulty and produced an oral response to an unfinished sentence. The examiner then marked the response as correct or incorrect. Descriptive output is presented in both raw score and grade equivalent form. Raw scores were used for all analyses. The test–retest reliability was reported by the test authors as .85 in Spanish and .81 in English.

Spanish and English Reading Comprehension

The measure of Spanish and English reading comprehension was the Woodcock Passage Comprehension (*Comprensión de textos*) test. On this cloze reading comprehension test the

student silently read passages in order of increasing difficulty and produced an oral response to an unfinished sentence. The examiner then marked the response as correct or incorrect. Descriptive output is presented in both raw score and grade-equivalent form. Raw scores were used for all analyses. The test–retest reliability was reported by the test authors as .92 for Spanish and .90 for English.

RESULTS

Table 2 displays the means, standard deviations, and ranges for all the modeled variables, and disaggregated by site. From the data, it was clear that this was a Spanish-dominant sample, with students being far more proficient in both decoding and oral-language skills in Spanish. Paired *t*-tests comparing Spanish and English performance revealed significant differences between languages for alphabetic knowledge, vocabulary knowledge, and listening comprehension, all in favor of Spanish. However, it is interesting to note that the average results on the reading comprehension did not differ significantly between English and Spanish.

While on average the sample was Spanish dominant, disaggregating the data by site showed significant differences among the three schools. There were no differences among the three sites on the Spanish and English measures of alphabetic knowledge; however, there were stark differences on the oral language and reading comprehension measures. Indeed, the Boston and Chicago sites showed more balance across both Spanish and English while students in El Paso were more clearly Spanish dominant and contributed heavily to the aggregated Spanish dominance of the full sample. One-way ANOVAs with Tukey's post-hoc testing revealed clear separations between the two northern schools (Boston and Chicago) and the southern school (El Paso). On English vocabulary and listening comprehension, Boston and Chicago students significantly outperformed their El Paso counterparts, but performed comparably to one another. The Chicago students significantly outperformed the El Paso students on English reading comprehension, and Boston performed comparably to both groups. By contrast, the El Paso students significantly outperformed both Boston and Chicago students on the Spanish vocabulary, listening, and reading measures.

To account for the differences, multiple regression analyses were run that replicated those posited in the path model displayed in Figure 1 (i.e., English Reading = English Oral Language + Decoding + Spanish Reading; Spanish Reading = Spanish Oral Language + Decoding). We then individually added a dummy-coded variable for Boston, Chicago, and El Paso (1 = yes, 0 = no) to determine whether site played a significant role in predicting reading in both outcomes. In these models, site was not significant in predicting English reading comprehension for Boston ($t = -0.90$, $p = .37$), Chicago ($t = 0.54$, $p = .59$), or Texas ($t = 0.34$, $p = .74$). Site was approaching significance in predicting Spanish reading comprehension for Boston ($t = -1.87$ $p = .09$) and El Paso ($t = 1.69$, $p = .07$), but not for Chicago ($t = 0.36$, $p = .72$). Given the lack of statistical differences between schooling sites when taking into account the predictive power of the linguistic covariates on the Spanish and English reading outcomes, we determined the original model was stable as hypothesized.

Next, correlations between the Spanish and English language and literacy variables were calculated (Table 3). In both Spanish and English, there was a strong correlation between listening comprehension and vocabulary knowledge ($r = .64$, $p < .001$ in Spanish, $r = .81$, $p < .001$ in

TABLE 2
Means, Standard Deviations, and Ranges for All Model Variables

	Percentage Correct		
Decoding Variables	*M*	*SD*	*Range*
English Alphabetic Knowledge (% Correct)	73.0	19.7	18.8–100.0
Boston	74.6	21.9	18.8–100.0
Chicago	74.6	17.8	20–96.3
El Paso	69.9	19.8	27.6–96.0
Spanish Alphabetic Knowledge (% Correct)	85.8	16.8	0–100
Boston	82.9	25.8	0–100.0
Chicago	84.8	13.6	33.0–100.0
El Paso	89.4	4.2	75.9–96.6
	Raw Scores (Grade Equivalencies)		
Comprehension Variables	*M*	*SD*	*Range*
English Vocabulary Knowledge	23.7 (1.1)	5.0 (1.3)	13–33 (PK–4.9)
Boston	25.8[a]	4.3	16–33
Chicago	25.3[a]	3.5	18–33
El Paso	20.4	5.1	13–33
Spanish Vocabulary Knowledge	26.2 (4.0)	4.0 (2.3)	15–33 (PK–9)
Boston	23.6	4.5	15–30
Chicago	26.3	2.5	21–30
El Paso	28.4[b]	3.4	20–33
English Listening Comprehension	15.7 (1.3)	5.8 (2.2)	1–27 (PK–16.9)
Boston	17.7[a]	5.4	1–25
Chicago	17.3[a]	3.8	10–24
El Paso	12.4	6.4	1–27
Spanish Listening Comprehension	21.7 (3.7)	4.6 (2.6)	9–31 (PK–13)
Boston	20.0	4.0	9–27
Chicago	19.5	3.8	12–27
El Paso	25.4[b]	3.2	20–31
English Reading Comprehension	16.8 (3.2)	4.4 (1.2)	6–28 (1.3–8.3)
Boston	17.4	3.6	9–23
Chicago	17.8[c]	3.7	10–28
El Paso	15.1	5.1	6–24
Spanish Reading Comprehension	21.0 (3.5)	5.1 (1.3)	4–32 (PK–8.1)
Boston	18.2	5.8	4–28
Chicago	20.2	3.4	10–25
El Paso	24.3[b]	4.1	14–32

[a] = Boston and Chicago significantly outperform El Paso; [b] = El Paso significantly outperforms Boston and Chicago; [c] = Chicago significantly outperforms El Paso. All *p*s < .05. Site comparisons for comprehension variables were conducted using raw scores only. Thus, the site-level disaggregated data display raw scores only.

English), which portended that a single oral-language factor would likely emerge. However, the cross-linguistic correlation between Spanish and English alphabetic knowledge was not as high as initially expected ($r = .35$, $p < .01$). Interestingly, the cross-linguistic association between Spanish reading comprehension and English alphabetic knowledge was mild yet significant ($r = .30$,

TABLE 3
Correlation Matrix for All Observed Spanish and English Variables

	1.	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*
Spanish Skills							
1. Alphabetic Knowledge							
2. Vocabulary Knowledge	0.44***						
3. Listening Comprehension	0.43***	0.64***					
4. Reading Comprehension	0.65***	0.74***	0.69***				
English Skills							
5. Alphabetic Knowledge	0.35**	0.02	0.09	0.30**			
6. Vocabulary Knowledge	–0.18	–0.15	–0.18	–0.14	0.36**		
7. Listening Comprehension	–0.13	–0.08	–0.07	–0.09	0.39***	0.81***	
8. Reading Comprehension	0.08	0.07	0.07	0.18	0.54***	0.69***	0.76***

***$p < .001$ **$p < .01$, *$p < .05$, ~$p < .10$

$p < .01$). Such a significant relationship was absent, however, between Spanish alphabetic knowledge and English reading comprehension ($r = .08$, ns).

Principal Components Analysis

Table 4 displays the results from the principal components analysis. All three latent constructs loaded onto a single factor with an eigenvalue over 1, with high percentages of variation explained. Ninety-one percent of the variation in the English oral-language construct was explained with the two observed measures while Spanish oral-language loaded strongly with over 80% of variation explained in the latent construct. Finally, the Spanish–English decoding factor held up rather well, with 68% explained variation and strong factor loadings (.82). Finally, the correlation matrix displayed in Table 5 shows that the Spanish–English decoding factor correlated positively but mildly with oral language in both languages and moderately with reading comprehension in both languages.

TABLE 4
Results from Principal Components Analysis for Commutable Decoding, Spanish Oral Language, and English Oral Language

	Eigenvalue	*% Explained Variation*	*Loading*
Spanish–English Decoding	1.35	67.5	
Spanish Alphabetic Knowledge			0.82
English Alphabetic Knowledge			0.82
Spanish Oral Language	1.64	82.2	
Spanish Vocabulary			0.91
Spanish Listening Comprehension			0.91
English Oral Language	1.81	90.6	
English Vocabulary			0.95
English Listening Comprehension			0.95

TABLE 5
Correlation Matrix for Spanish and English Path Model Variables

	1.	*2.*	*3.*	*4.*
Global Skills				
1. Spanish–English Decoding				
Spanish Skills				
2. Oral Language	0.25*			
3. Reading Comprehension	0.52**	0.78**		
English Skills				
4. Oral Language	0.21~	−0.13	−0.11	
5. Reading Comprehension	0.44**	0.08	0.18	0.76**

**$p < .01$, *$p < .05$, ~$p < .10$

Structural Equation Modeling

The method for estimating the structural equations among the variables was ordinary least squares. As a primary means of model fit, the level of significance of a specified path was considered (i.e., $t \geq 1.96$). Following recommendations by Hu and Bentler (1999) and practical applications by Holopainen, Ahonen, Tolvanen, and Lyytinen (2000), the fit of the model was also assessed using a variety of goodness-of-fit measures, including: chi-square (χ^2), root mean square error of approximation (RMSEA), normed fit index (NFI), comparative fit index (CFI), and adjusted goodness-of-fit index (AGFI). Figure 2 below displays the results for the hypothesized model.

The model fit the data well (χ^2 [2, N = 91] = 3.09, p = .21, RMSEA = .08, NFI = .98, CFI = .99, AGFI = .90) and showed degrees of cross-linguistic relationships among the variables that were consistent with the interdependence continuum. At the alphabetic level, Spanish–English alphabetic knowledge predicted both Spanish and English reading comprehension. The standardized coefficients were small (.20 for predicting English comprehension, .36 for Spanish) relative to

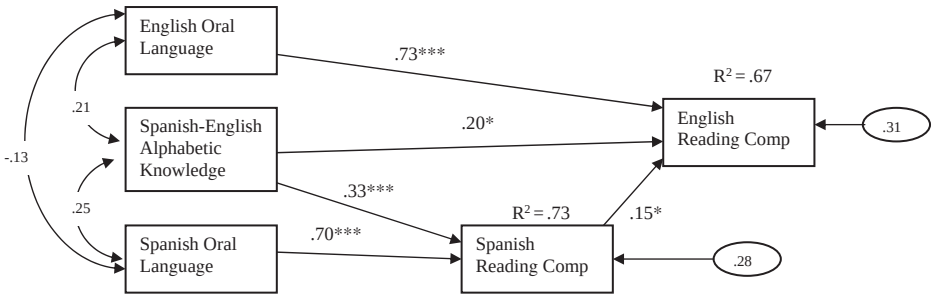

FIGURE 2 Results from LISREL structural equation modeling of theory-driven path model predicting both Spanish and English reading comprehension (χ^2 [2, N = 91] = 3.09, p = .21). Results are standardized for ease of interpretation. ***$p < .001$, **$p < .01$, *$p < .05$, ~$p < .10$.

the effect that oral-language proficiency in Spanish and English had on comprehension in their respective languages. These relationships were consistent with the research base showing that linguistic skills tend to explain relatively high amounts of variation compared with decoding skills among upper elementary students (e.g., Hoover & Gough, 1990). Also consistent with the literature reviewed was the small but significant effect of Spanish reading comprehension on English reading comprehension. This proximal relationship with English reading also created a distal one between Spanish oral language and English reading, lending further support to an interdependence continuum.

DISCUSSION AND CONCLUSIONS

The purpose of this study was to propose and test a continuum of interdependence among a restricted set of language and literacy variables that also modeled Spanish–English reading as a holistic process. Based on the literature, we theorized strong associations between Spanish and English alphabetic knowledge, and indeed the cross-linguistic decoding variable predicted reading comprehension in both English and Spanish, though alphabetic knowledge in Spanish and English were less strongly associated than has been shown in previous research. In a similar study, Nakamoto, Lindsey, and Manis (2008) used confirmatory factor analysis and determined that a common factor of Spanish-English alphabetic knowledge was not appropriate for their sample of bilingual learners. English reading comprehension was significantly associated with Spanish reading comprehension, though the effect was weaker than for Spanish–English decoding. However, the proximal association between Spanish and English reading created the distal link between Spanish oral-language skills and English reading comprehension, which has been observed in the literature, albeit infrequently (e.g., Dufva & Voeten, 1999).

By modeling reading cross-linguistically among a specific group of bilingual learners (i.e., Spanish–English biliterates), we sought to present the reading processes as both dynamic yet recursive. Thus, assuming the presence of quality instruction that attends to the dynamic nature of bilingualism and biliteracy, the recursive nature of these results suggest that biliterate outcomes may be optimized by literacy instruction delivered in L1 and L2 simultaneously. However, there still exists no well-mechanized explanation for transfer, especially one that might: (a) provide a reliable definition of transfer, (b) predict when transfer is positive versus negative, and (c) predict when it would be strong versus weak. Such was the purpose of the current study. Merging the theoretical lines developed by Cummins (1979, 1991), Snow and Kim (2006), and Hornberger (1989, 2004), we sought to present a model of linguistic interdependence that could be applied psycholinguistically. However, there are also implications for interdisciplinary applications of the interdependence continuum.

Recent work by Gilanders and Jiménez (2004), Gutiérrez (2008), and Villalva (2006) take ethnographic and sociocritical approaches to understand how bilingual children and adolescents negotiate bilingualism and literacy across various school settings. Future research in the arena of interdependence should continue to investigate innovative and rigorous methodological techniques that provide deeper insights into the nature of linguistic interdependence and transfer. For example, Gutiérrez's (2008) sociocritical work describes "hybrid language practices in which students use their complete linguistic tool kit in the service of learning and the production of

texts" (p. 150). Approaches such as these align themselves with Hornberger's (1989, 2004) Biliterate Context domain, and stand to complexify the way in which we define and study interdependence. Inescapable links between language and culture might lead researchers to define transfer more qualitatively, occurring within individual students' "horizontal forms of learning, the movement, into students' understandings of texts, social theory, and writing conventions (Gutiérrez, 2008, p. 150).

Another important aspect of this study is that it produced a model of Spanish reading comprehension, something that is rarely studied in American research on bilingual and biliterate populations (see also Nakamoto et al., 2008). The results found here suggest that both oral language in Spanish and alphabetic knowledge are important in the comprehension process, and that, by the fourth grade, oral-language skills are more predictive of comprehension outcomes than are decoding processes. These findings are consistent with a great deal of reading research on English reading comprehension, both for Spanish–English bilinguals (Proctor, Carlo, August, & Snow, 2005; Cirino et al., 2009; Hoover & Gough, 1990; Pollard-Durodola et al., 2006), as well as for English monolinguals (National Institute of Child Health and Human Development, 2000; Snow, Burns, & Griffin, 1998). The instructional conclusion to be drawn from this research is that English literacy attainment may in fact be aided by native language and literacy development. However, it is not sufficient to simply provide access to L1 language development (e.g., teacher and student use of the L1 in instructional settings). Rather, to reap the potential benefits of interdependence, instruction must focus on language and literacy development in both languages, and indeed focus directly on explicitly teaching for transfer (M. Carlo, personal communication, September 12, 2009).

There is a basis for hypothesizing the degrees to which different language literacy skills are interdependent. Findings inform theoretical discussions about biliteracy, but can also promote thinking about instruction that is designed to promote transfer and, ultimately, academic achievement for bilingual learners in American schools. For example, teachers of second-language learners who are not proficient in the native languages of their students can apply understanding of language typologies and literacy skills to direct their instruction, recognize natural errors, and make distinctions between cognitive challenges broadly and second-language development more specifically. Further, taking time to consider the bilingual reading process as the interaction of literacy in two (or more) languages is a realm of research that has been championed in both sociocultural and psycholinguistic domains. The study of linguistic interdependence stands to bridge some historical differences between these research realms as interdisciplinary findings will help researchers and practitioners to more fully understand literacy development among bilingual learners.

ACKNOWLEDGMENTS

This project effort was supported by Grant Number P01HD03950 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Child Health and Human Development or the National Institutes of Health.

REFERENCES

Bialystok, E., Luk, G., & Kwan, E. (2005). Bilingualism, biliteracy, and learning to read: Interactions among languages and writing systems. *Scientific Studies of Reading, 9*(1), 43–61.

Carlisle, J. F., Beeman, M. M., Davis, L. H., & Spharim, G. (1999). Relationship of metalinguistic capabilities and reading achievement for children who are becoming bilingual. *Applied Psycholinguistics*, *20*(4), 459–478.

Cirino, P. T., Vaughn, S., Linan-Thomspon, S., Cárdenas-Hagan, E., Fletcher, J., & Francis, D. J. (2009). One-year follow-up outcomes of Spanish and English interventions for English language learners at risk for reading problems. *American Educational Research Journal, 46*(3), 744–781.

Cisero, C. A., Royer, J. M., Marchant, H. G., & Jackson, S. J. (1997). Can the Computer-Based Academic Assessment System (CAAS) be used to diagnose reading disability in college students? *Journal of Educational Psychology, 89*(4), 599–620.

Coady, J. (1997). L2 vocabulary acquisition through extensive reading. In J. Coady and T. Huckin (Eds.), *Second language vocabulary acquisition: A rationale for pedagogy* (pp. 225–237). Cambridge, England: Cambridge University Press.

Cummins, J. (1979). Linguistic interdependence and the educational development of bilingual children. *Review of Educational Research, 49*, 222–251.

Cummins, J. (1991). Interdependence of first and second language proficiency in bilingual children. In E. Bialystok (Ed.), *Language processing in bilingual children* (pp. 70–89). New York, NY: Cambridge University Press.

DaFortuna, H. A., & Siegel, L. S. (1995). Reading, syntactic, and working memory skills of bilingual Portuguese-English Canadian children. *Reading and Writing: An Interdisciplinary Journal, 7*, 139–153.

Dressler, C., & Kamil, M. (2006). First- and second-language literacy. In D. August & T. Shanahan (Eds)., *Developing literacy in second-language learners* (pp. 197–238). Mahwah, NJ: Erlbaum.

Dufva, M., & Voeten, M. J. M. (1999). Native language literacy and phonological memory as prerequisites for learning English as a foreign language. *Applied Psycholinguistics*, *20*(3), 329–348.

Durgunoğlu, A. Y., Nagy, W. E., & Hancin-Bhatt, B. (1993). Cross-language transfer of phonological awareness. *Journal of Educational Psychology, 85*(3), 453–465.

García, O., Kleifgen, J. A., & Falchi, L. (2008). From English language learners to emergent bilinguals. In *Equity Matters: Research Review, No. 1*. New York: Teachers College, Columbia University.

Genessee, F., & Geva, E. (2006). Cross-linguistic relationships in working memory, phonological processes, and oral language. In D. August & T. Shanahan (Eds.), *Developing literacy in second-language learners* (pp. 175–184). Mahwah, NJ: Erlbaum.

Gholmain, M., & Geva, E. (1999). Orthographic and cognitive factors in the concurrent development of basic reading skills in English and Persian. *Language Learning, 49*(2), 183–217.

Gilanders, C., & Jiménez, R. T. (2004). Reaching for success: A close-up of Mexican immigrant parents who foster literacy success for their kindergarten children. *Journal of Early Childhood Literacy, 4*(3), 243–269.

Gutiérrez, K. D. (2008). Developing a sociocritical literacy in the third space. *Reading Research Quarterly, 43*(2), 148–164.

Hancin-Bhatt, B., and Nagy, W. (1994) Lexical transfer and second language morphological development. *Applied Psycholinguistics*, *15*(3), 289–310.

Holopainen, L., Ahonen, T., Tolvanen, A., & Lyytinen, H. (2000). Two alternative ways to model the relation between reading accuracy and phonological awareness at preschool age. *Scientific Studies of Reading, 4*(2), 77–100.

Hoover, W. A., & Gough, P. B. (1990). The simple view of reading. *Reading and Writing: An Interdisciplinary Journal, 2*, 127–190.

Hornberger, N. H. (1989). Continua of biliteracy. *Review of Educational Research, 9*(3), 271–296.

Hornberger, N. H. (2004). The continua of biliteracy and the bilingual educator: Educational linguistics in practice.*International Journal of Bilingual Education and Bilingualism, 7*(2&3), 155–171.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55.

Jiménez, R. T., García, G. E., and Pearson, P. D. (1996) The reading strategies of bilingual Latina/o students who are successful English readers: Opportunities and obstacles. *Reading Research Quarterly, 31*(1), 90–112.

Lee, J., & Schallert, D. L. (1997). The relative contribution of L2 language proficiency and L1reading ability to L2 reading performance: A test of the threshold hypothesis in an EFL context. *TESOL Quarterly, 31*(4), 713–739.

Nagy, W. E., García, G. E., Durgunoglu, A. Y., and Hancin-Bhatt, B. (1993) Spanish–English bilingual students' use of cognates in English reading. *Journal of Reading Behavior, 25*(3), 241–259.

Nagy, W. E., McClure, E. F., & Mir, M. (1997). Linguistic transfer and the use of context by Spanish–English bilinguals. *Applied Psycholinguistics*, *18*(4), 431–452.

Nakamoto, J., Lindsey, K. A., & Manis, F. R. (2008). A cross-linguistic investigation of English language learners' reading comprehension in English and Spanish. *Scientific Studies of Reading, 12*, 351–371.

National Institute of Child Health and Human Development. (2000). *Report of the National Reading Panel. Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction* (NIH Publication No. 00-4769). Washington, DC: U.S. Government Printing Office.

Ordóñez, C. L., Carlo, M. S., Snow, C. E., & McLaughlin, B. (2002). Depth and breadth of vocabulary in two languages: Which vocabulary skills transfer? *Journal of Educational Psychology*, *94*(4), 719–728.

Pollard-Durodola, S. D., Mathes, P., Cárdenas-Hagan, E., Linan-Thompson, S., & Vaughn, S. (2006). The role of oracy in developing comprehension in Spanish-speaking English language learners. *Topics in Learning Disorders*, *26*(4), 362–381.

Proctor, C. P., Carlo, M. S., August, D., & Snow, C. E. (2005). Native Spanish-speaking children reading in English: Towards a model of comprehension. *Journal of Educational Psychology*, *97*(2), 246–256.

Proctor, C. P., August, D., Carlo, M. S., & Snow, C. E. (2006). The intriguing role of Spanish language vocabulary knowledge in predicting English reading comprehension. *Journal of Educational Psychology 98*(1), 159–69.

Proctor, C. P. & Mo, E. (2009). The Relationship between cognate awareness and English comprehension among Spanish-English bilingual fourth grade students. *TESOL Quarterly*, *43*(1), 126–136.

Schoonen, R., Hulstijn, J., & Bossers, B. (1998). Metacognitive and language-specific knowledge in native and foreign language reading comprehension: An empirical study among Dutch students in grades 6, 8, and 10. *Language Learning, 48*(1), 71–106.

Sinatra, G. M., & Royer, J. M. (1993). Development of cognitive component processing skills that support skilled reading. *Journal of Educational Psychology*, *85*(3), 509–519.

Slavin, R. E., Madden, N. A., Dolan, L. J., & Wasik, B. A. (1996). *Every child, every school: Success for all*. Newbury Park, CA: Corbin.

Snow, C. E. (1992). Perspectives on second-language development: Implications for bilingual education. *Educational Researcher 21*(2), 16–19.

Snow, C. E., Burns, M. S., & Griffin, P. (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy Press.

Snow, C. E., & Kim, Y.S. (2006). Large problem spaces: The challenge of vocabulary for English language learners. In R. K. Wagner, A. Muse, & K. Tannenbaum (Eds.), *Vocabulary acquisition and its implications for reading comprehension*. New York: Guilford Press.

Verhoeven, L. T. (1994). Transfer in bilingual development: the linguistic interdependence hypothesis revisited. *Language Learning, 44*, 381–415.

Villalva, K. E. (2006). Hidden literacies and inquiry approaches of bilingual high school writers. *Written Communication, 23*(1), 91–129

Woodcock, R. W. (1991). *Woodcock language proficiency battery—revised, English form: examiner's manual*. Chicago, IL: Riverside.

Woodcock, R. W., & Muñoz-Sandoval, A. F. (1995). *Woodcock language proficiency battery—revised, Spanish form: supplemental manual*. Itasca, IL: Riverside.