Effect of initial status and growth in pseudoword reading on Spanish reading comprehension at the end of first grade

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This study analyzes the effect of initial status and growth in Spanish pseudoword reading in kindergarten and first grade on reading comprehension in Spanish at the end of first grade. One hundred and sixty-eight Spanish-speaking English learners who were learning to read in Spanish and English in the United States participated in the study. Results of hierarchical linear modeling indicate that students grew, on average, by 95 letter-sounds in Spanish from the middle of kindergarten to the end of first grade. Structural equation modeling indicated that 53% of the variance in Spanish reading comprehension at the end of first grade was explained by Spanish initial status on pseudoword reading, Spanish kindergarten overall reading performance, and growth in Spanish pseudoword reading. Findings are important in a Response to Intervention approach where screening and progress monitoring of pseudoword reading helps educators determine the level of support beginning readers need to acquire the alphabetic principle, an important skill that contributes substantially to Spanish reading comprehension.

Efecto del estado inicial y progreso en lectura de pseudopalabras sobre la comprensión lectora en español al finalizar el primer grado. Este estudio analiza el efecto del estado inicial y progreso en lectura de pseudopalabras en niños españoles de Educación Infantil y primer grado sobre la comprensión lectora al finalizar el primer grado. Ciento sesenta y ocho estudiantes de habla española que estaban aprendiendo a leer en español e inglés en los Estados Unidos participaron en el estudio. Los resultados del modelo jerárquico lineal indican que los estudiantes alcanzaron un promedio de aprendizaje de 95 sonidos de letras en español desde la mitad del jardín de infantes hasta finalizar el primer grado. Modelos de ecuaciones estructurales indicó que al finalizar el primer grado el 53% de la varianza en comprensión lectora de español se explica por el estado inicial de lectura de pseudopalabras, el rendimiento global de lectura en español en el período de Educación Infantil, y el progreso en lectura de pseudopalabras en español. Los hallazgos son importantes y con implicaciones para un modelo de respuesta a la intervención ya que tanto en la detección como en el seguimiento el control de los avances que se producen en la lectura de pseudopalabras ayudaría a los profesores a determinar el nivel de apoyo que necesitan los lectores principiantes para adquirir el principio alfabético, una habilidad importante que contribuye sustancialmente a la comprensión lectora en español.

A foundational skill of reading proficiency in alphabetic languages is understanding and using the alphabetic principle, that is, the knowledge that letters of the alphabet and the phonemes to which they correspond can be used to read words. The alphabetic principle is comprised of two fundamental skills: (a) knowledge of letter-sound correspondences, and (b) the ability to blend phonemes to read words. Extensive research in English indicates that reading and understanding connected text is dependent on acquiring automaticity in the alphabetic principle, and students who struggle to acquire the alphabetic principle fail to develop early, successful word reading skills (Adams, 1990; Harn, Stoolmiller, & Chard, 2008; Hogaboam & Perfetti, 1975; Stanovich, 2000).

According to Torgesen, Rashotte, & Alexander (2001), a primary difference between good and poor readers in English is the ability to use letter-sound correspondences to decode words. Poor readers tend to have difficulty reading words accurately and instantly, indicating an incomplete representation of words in memory. Similar results have been found in Spanish (Bravo-Valdivieso, 1995; Genard, Alegría, Leybaert, Mousty, & Defior, 2005; Signorini, 1997). Moreover, because Spanish has a transparent orthographic system, meaning that most letters represent one sound, and differences in pronunciation follow grapheme-phoneme correspondence rules (e.g., the letter «c» is pronounced as /s/ before «e» or «i») learning the letter-sounds and grapheme-phoneme correspondence rules in Spanish allows students to decode all words in Spanish (Defior, Martos, & Cary, 2002; Jiménez & O'Shanahan Juan, 2008; Signorini, 1997).

The most common way of measuring student acquisition of the alphabetic principle is pseudoword reading (Good, Baker, & Peyton, 2009). Pseudowords are not «real» words. They are non-words (in Spanish an example is «panu») in which students must

apply the alphabetic principle to sound out or read the pseudoword correctly. Of the 38 studies included in the National Reading Panel report (NRP, 2000) on English interventions to teach reading using phonics (i.e., the instructional approach associated with explicit instruction in the alphabetic principle), 18 included a measure of pseudoword reading to determine impact. The report concluded that in English, systematic phonics instruction in kindergarten and 1st grade is highly beneficial and that children ages 5-7 are quite capable of learning phonemic awareness and phonics concepts.

Studies in languages with a highly transparent orthography like Spanish, German, Finnish, and Greek also indicate that students make greater gains in word recognition accuracy, fluency, and conventional spelling in the first few years of schooling when they learn phonics. Moreover, by the end of first grade, children learning phonics in languages with a transparent orthography can reach mastery levels of accuracy of word and pseudoword reading (Caravolas, 2005; Genard et al., 2005; Seymour, 2005).

Emerging research in English indicates that growth rates on measures of word and pseudoword reading are strongly associated with student reading comprehension in later grades. For example, Good et al., (2009) found that growth on a pseudoword reading measure (i.e., DIBELS Nonsense Word Fluency (DIBELS, NWF), Good & Kaminski, 2002) during the first semester of first grade accounted for 27% of the variance in reading outcomes at the end of first grade for students at high risk of reading difficulties, and 9% of the variance in reading outcomes at the end of first grade for students at low risk of reading difficulties. In other words, the growth poorer readers made on the alphabetic principle accounted for more of the variance in overall reading outcomes, including comprehension, than the growth made by students who were already on their way towards proficiency in the alphabetic principle.

Fien et al., (2008) examined the predictive validity of the DIBELS NWF measure for English speakers and English language learners in first graders in the United States who were being taught to read using a highly explicit phonics-based approach. Results indicated that DIBELS NWF predicted equally well reading comprehension for both groups of students, and that the degree to which students thoroughly learned the alphabetic principle was associated with better reading comprehension. Although this study did not address the value of growth of pseudoword reading on reading comprehension, the findings support prior research on the validity of using pseudoword reading to measure early reading proficiency, and to make instructional decisions based on student ability to apply the alphabetic principle when reading words.

We are not aware of any studies in Spanish that have examined either (a) how students grow in terms of pseudoword reading proficiency (e.g., typical and atypical rates of growth during first grade) or (b) whether growth in pseudoword reading explains variance in reading comprehension. Investigating the growth trajectories on pseudoword reading is important in a Response to Intervention (RtI) system (i.e., a system where students who are at risk for school failure are provided with early intervention) because amount of growth is a central principle of RtI. Students who fail to make enough growth over a certain period of time in an RtI system receive additional instructional support designed to increase their rate of growth. This support is intended to provide the necessary scaffolding for students when there is still time to influence their reading trajectories (Baker & Baker, 2008; Gersten et al., 2009).

The purpose of this study is to analyze the association between rate of development in learning the alphabetic principle, as measured by growth on pseudoword reading proficiency, and reading comprehension for Spanish-speaking kindergarten and first-grade students learning to read in Spanish in the United States. Specifically, we attempt to answer the following research questions.

1. What is the estimated average initial status and growth rate in pseudoword reading in Spanish from the middle of kindergarten to the end of first grade for Spanish-speaking students in the United States?
2. Controlling for initial status on pseudoword reading in the middle of kindergarten and overall reading proficiency at the end of kindergarten, does growth on pseudoword reading add significantly to the prediction of reading comprehension at the end of first grade?

We focus on Spanish-speaking English learners in the United States because this population of students is at a significantly elevated risk for school failure compared to their peers (National Assessment of Educational Progress [NAEP], 2007). Although students in our sample were also learning to read in English, in this study, we analyze only student reading performance in Spanish, the students' native language. This study may have relevance for teachers providing Spanish reading instruction for English learners in the United States as well as for teachers teaching reading in Spanish in Spanish-speaking countries.

Method

Participants

Students. Participants were 168 students in three different cohorts with intact data in kindergarten and first grade. Eighty-two (49.4%) students were boys, and 84 (50.6%) were girls (gender was missing for two students). All students spoke Spanish as their primary language at home, and all were classified by the state as Limited English proficient (LEP), a federal designation category that entitles students to services to assist with their academic development as they are learning English.

Schools. Students in this study attended four schools in the Pacific Northwest in the United States. The percentage of students in the four schools that received free or reduced rate meals ranged from 64% to 84% (free and reduced lunch is a measure of student socioeconomic status in US schools). All the schools provided 90 minutes of daily Spanish reading instruction five days a week and all schools used the Houghton Mifflin Lectura (2003) Spanish reading program as the basis of reading instruction. In the summer prior to this study, Spanish reading teachers received extensive professional development on the implementation of the Lectura program. In addition, a regional coordinator fluent in Spanish visited schools monthly to observe, model, and provide feedback to teachers on their delivery of Spanish reading instruction. During the 90-minute Spanish block, students received at least 30 minutes of small group instruction in homogenous groups (i.e., reading groups were composed of students with similar skills). The primary focus of small group instruction was to re-teach material presented during whole group instruction.

Measures

IDEL Fluidez en las Palabras sin Sentido (*FPS;* Plasencia-Peinado, Baker, Good III, & Peinado, 2006). FPS was administered five times: in the middle and the end of kindergarten, and in the beginning, middle, and end of first grade. FPS is a standardized, individually administered test of Spanish pseudoword reading. It assesses (a) knowledge of letter-sound correspondences, and (b) knowledge of the ability to blend letters into words. The student is presented a sheet of paper with randomly ordered CV and CVCV nonsense words (e.g., panu, lu, mosi) and asked to produce verbally the individual sound of each letter or to read the whole nonsense word. For example, if the stimulus word is «panu» the student could say /p/ /a/ /n/ /u/ or say the entire pseudoword /panu/ all at once to obtain a maximum score of four correct letter-sounds. The student is tested for 1 minute to produce as many letter-sounds as possible, and the final score is the number of letter-sounds produced correctly in one minute.

The three-week alternate-form reliability for FPS in the middle of first grade is .76 (Baker, Good III, Peyton, & Watson, 2004). The concurrent criterion-related validity of FPS with the Woodcock-Muñoz Pruebas de Aprovechamiento subtest of Análisis de Palabras is .72 at the end of first grade (Watson, 2004).

Aprenda-3 (Harcourt Brace Educational Measurement, 2005). The Aprenda-3 is a group administered, multiple-choice standardized test of reading achievement. The measure is not timed, although guidelines with flexible time recommendations are given. Aprenda was standardized with 73,000 students from 131 school districts in 13 states in the United States, and in Puerto Rico and Mexico. For this study we used the Aprenda Preprimario 2 and Aprenda Primario 1 levels. Kuder-Richardson reliability coefficients for the Spanish-speaking school population in the end of kindergarten, and first grades ranged from .93 to .96.

The Aprenda-3 Preprimario 2 was administered at the end of kindergarten. The test consists of three subtests: Sonidos y Letras, Lectura de Palabras, and Lectura de Oraciones that measure: phonological awareness, orthographic awareness, alphabetic principle, word recognition, and sentence comprehension. The Aprenda-3 Primario 1 reading comprehension subtest assesses student comprehension at the end of first grade on three types of material: (a) literary, (b) informational, and (c) functional. Students are asked to read ten different types of text and answer multiple choice comprehension questions. The subtest is untimed, and estimated time of completion is fifty minutes.

Data collection procedure

Students were assessed five times, from the middle of kindergarten to the end of first grade. Test administrators received a full day of training on administration and scoring of the IDEL measure in the beginning of the year. Prior to each testing, a two-hour refresher training on test administration and scoring was provided to all test administrators by the first author and reading coaches in each school.

Administration of the Aprenda-3 at the end of kindergarten and first grade was conducted by classroom teachers and reading coaches at each individual school. Coaches received a two-hour training on how to administer these tests.

Data analysis

Two main analytic approaches were used to answer our research questions. First, we used hierarchical linear models (HLM) to estimate the average initial score and growth rate in Spanish pseudoword reading. Second, we applied a structural equation modeling (SEM) approach to explore the relations between FPS initial status, growth rates, and reading comprehension outcomes. Although both analytic approaches are efficient tools for growth modeling and share many features, each is unique in its application and presentation. HLM is a proper approach to analyze longitudinal data when each participant in the study has data for multiple time points (Raudenbush & Bryk, 2002); see Appendix 1 for our model). SEM, however, has more flexibility in terms of model specification (Duncan, Duncan, & Strycker, 2006; Wendorf, 2002) allowing better exploration of the relations between latent variables and dependent variables within the same model. In terms of growth models, HLM and SEM should produce the same estimates.

Results

Descriptive statistics

Table 1 presents the means and standard deviations. Student average scores on pseudoword reading improved from 15.18 (*SD*= 14.72) in the winter of kindergarten to 113.83 (*SD*= 44.12) in the spring of first grade, a substantial amount. Students scored, on average, 497.08 points (*SD*= 32.21) on the Aprenda total reading score at the end of kindergarten, and 551.79 points (*SD*= 33.61) on the Aprenda reading comprehension subtest at the end of first grade.

Growth on Spanish pseudoword reading from the middle of Kindergarten to the end of first grade

To estimate average initial status and growth rate, we compared three alternative hierarchical linear models that had different assumptions about variance-covariance structures. All three models included the same fixed coefficients: initial status (β_{00}), growth rate (β_{10}), and summer drop (β_{20}). We included summer drop because we expected a change in trajectories (i.e., non-linear growth) during the summer months when students were out of school. Table 2 presents the results from these three models for Spanish pseudoword reading growth.

Table 1
Descriptive statistics of pseudoword reading and reading comprehension

Grade / Test	Mean	SD
Kindergarten		
FPS in the middle	15.18	14.72
FPS in the end	39.15	26.90
Aprenda total reading in the end	497.08	32.21
First grade		
FPS in the beginning	33.48	29.07
FPS in the middle	75.51	37.61
FPS in the end	113.83	44.12
Aprenda reading comprehension in the end	551.79	33.61

Note: FPS= IDEL *Fluidez en las Palabras sin Sentido*

Model 1 assumes that the variances are the same at every time point of assessment and all subjects have the same slopes or growth rates. Model 2 has a different assumption about level-1 variance from the previous model. It assumes heterogeneous level-1 variance in Spanish pseudoword reading at different time points. Model 3 assumes that the slopes for growth rates vary randomly for different subjects (i.e., students are assumed to have different growth rates in their Spanish pseudoword reading), represented by an additional level-2 variance component (τ_{11}) in the model. Because no significant variance in summer drop was found, we set this slope as fixed.

To best estimate initial status and growth rates, we compared the model fit of the three models. Model fit improved significantly from model 1 to model 2 to model 3 as smaller model deviance means better fit (deviance difference between model 1 and 2 was 118.47, df= 4, $p<.001$, and deviance difference between model 2 and 3 was 150.23, df= 2, p<.001). Model 3 fit the data better than any other model indicating that individual differences had an effect on amount of growth in pseudoword reading.

According to results of model 3 in Table 2, the average initial score of FPS was 13 points (β_{00}= 13.29, SE= 1. 17, $p<.001$). The estimated average growth rate of FPS was 35 points between each time point of assessment (β_{10}= 34.64, SE= 1.12, $p<.001$). The estimated summer drop was 45 points (β_{20}= -45.01, SE= 1.12, $p<.001$). The actual drop in performance during summer vacation between kindergarten and first grade was about 10 points (β_{10} + β_{20}= -10.37).

Prediction of Spanish reading comprehension by pseudoword reading initial status and growth

To address the question of how the estimated initial status and growth rates of Spanish pseudoword fluency would predict later reading outcomes, we explored the relations of kindergarten and first grade pseudoword reading fluency growth on reading comprehension at the end of first grade. Several structural equation models were examined that included 1st grade reading comprehension scores, kindergarten total reading scores, and latent variables of pseudoword reading growth specified by using the growth model from the HLM analysis above.

The only difference between these structural equation models and previous hierarchical linear models was that we could adjust the models by reflecting different growth rates for different periods. We knew, for instance, that on average, students acquired more letter sounds in first grade than in kindergarten. We specified this nonlinear acceleration pattern in pseudoword reading growth during kindergarten and first grade by putting different path weights from the latent variable of FPS growth rate to FPS scores in different grades in our analysis.

Under the linear growth assumption, the path weights for the five time points from the latent variable of FPS growth rate should be 0, 1, 2, 3, and 4 in time order. By considering slower FPS growth in kindergarten, we used instead 0, .8, 1.8, 3 and 4 for our models, resulting in a better model fit. After comparing the models with different specifications for the relations between latent variables of pseudoword reading growth and general reading outcomes, we found the most plausible structural model (see Figure 1). This model shows acceptable fit indices with the comparative fit index (CFI) of .93, and the standardized root mean square residual (SRMR) of .05, although the chi-square statistics was significant (chi-square= 73.71, df= 17, $p<.001$) among different fit indices. However, chi-square values are sensitive to the sample size and thus other fit indices may be preferred when the sample size is larger (Kline, 2004).

According to Figure 1 and Table 3, pseudoword reading growth rates during kindergarten and first grade had a significant and direct

Table 2
Comparison of competing models for the growth on Spanish pseudoword reading

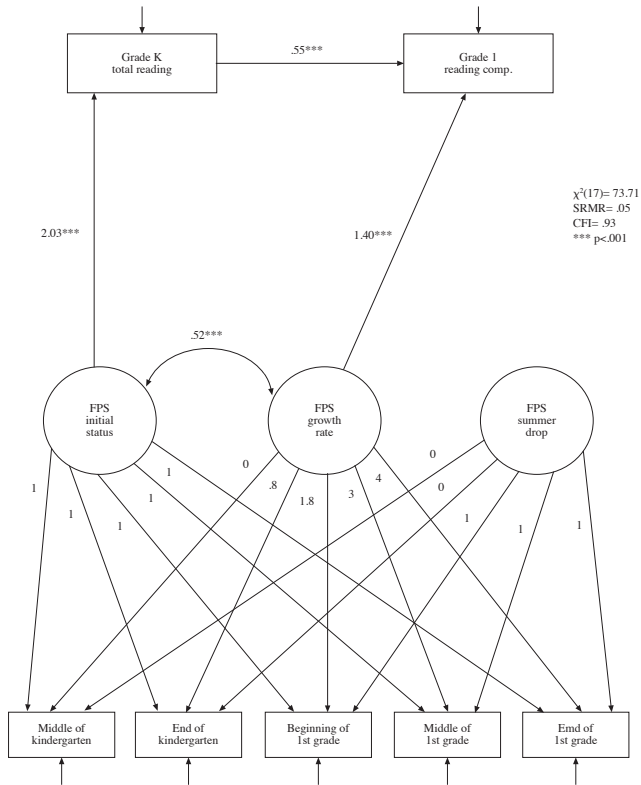| Level-2 Coefficients	Model 1 (Compound symmetry)			Model 2 (σ_t^2)			Model 3 (Random growth rate, σ_t^2)		
	Coefficient	SE	T Ratio	Coefficient	SE	T Ratio	Coefficient	SE	T Ratio
Average initial status, β_{00}	8.70	2.25	3.86 ***	9.41	1.95	4.82 ***	13.29	1.17	11.40 ***
Average growth rate, β_{10}	36.94	1.07	34.62 ***	34.37	1.06	32.56 ***	34.64	1.12	30.97 ***
Average summer drop, β_{20}	-45.24	3.08	-14.69 ***	-41.42	2.40	-17.23 ***	-45.01	2.55	-17.65 ***
Variance-Covariance Components									
Level 2	τ_{00}= 566.47			τ_{00}= 458.30			$\tau = \begin{matrix} 162.37 & 47.96 \\ & 59.07 \end{matrix}$		
							Corr(τ_{00}, τ_{11})= .49		
Level 1	σ^2= 478.12			σ_1^2= 276.93			σ_1^2= 74.68		
				σ_2^2= 221.75			σ_2^2= 346.64		
				σ_3^2= 234.67			σ_3^2= 239.36		
				σ_4^2= 636.78			σ_4^2= 373.72		
				σ_5^2= 1197.55			σ_5^2= 845.85		
Model Fit									
Deviance (df)	7891.58 (5)			7773.11 (9)			7622.88 (11)		

Figure 1. *SEM of the relation between Spanish pseudoword reading and reading comprehension*

reading comprehension score, even after controlling for FPS initial status and kindergarten reading scores. The FPS growth rates did not have a direct effect on end of kindergarten reading scores. However, initial status on FPS in the middle of kindergarten predicted reading performance at the end of kindergarten (*coefficient= 2.03, SE= .17, p<.001*). A 10-point higher FPS initial score predicted an about 20-point higher total reading score at the end of kindergarten.

FPS initial status in kindergarten did not have a direct prediction of first-grade reading comprehension, but it had an indirect prediction of first-grade reading comprehension through reading performance at the end of kindergarten. When other variables were controlled in the model, reading performance at the end of kindergarten directly predicted reading comprehension at the end of first grade. A 10-point higher reading score at the end of kindergarten predicted a 5.5-point higher reading comprehension score at the end of first grade. This model explained 53% of the variance in first-grade reading comprehension scores. Additional estimates from this model are presented in Table 3. It should be noted that the average FPS initial score, growth rate, and summer drop in Table 3 are slightly different from those in Table 2. This difference was not significant, and might have been the result of different model specifications of growth trajectories between HLM and SEM.

Discussion

The purpose of this study was to (a) estimate the growth rate on a pseudoword reading measure in Spanish from the middle of kindergarten to the end of first grade, and (b) examine the role of growth on FPS to the prediction of reading comprehension at the end of first grade after controlling for initial status. Results indicate that for our sample of students, the average growth rate between testing time points on FPS from the middle of kindergarten to the

prediction of Spanish reading comprehension scores at the end of first grade (*coefficient= 1.40, SE= .32, p<.001*). That is, a 10-point higher FPS growth rate predicts an approximately 14-point higher

	Unstandardized estimate	Standard error	Standard estimate	t	p
Regression weights					
Grade-1 RC ← Grade-K Reading	.55	.07	.52	8.15	<.001
Grade-K Reading ← Initial Status	2.03	.17	.84	11.68	<.001
Grade-1 RC ← Growth Rate	1.40	.32	.32	4.44	<.001
Covariance					
Initial Status ↔ Growth Rate	53.06	10.58	.52	5.02	<.001
Means					
Initial Status	14.30	1.20		11.89	<.001
Growth Rate	34.66	1.07		32.55	<.001
Summer Drop	-42.43	2.32		-18.28	<.001
Intercepts					
Grade-K Reading	468.00	3.12		149.88	<.001
Grade-1 RC	232.21	29.47		7.88	<.001
R square					
Grade-K Reading	.697				
Grade-1 RC	.525				
Grade-1 RC (without Grade-1 RC ← Growth Rate)	.442				

Table 3
Pseudoword reading initial status, growth and Aprenda preprimario scores predicting Spanish reading comprehension at the end of first grade

Note: RC= Reading Comprehension

end of first grade was 35 letter sounds per minute, a substantial amount. Specifically, a 10-point higher growth rate on FPS, resulted in a 14 point increase in first grade reading comprehension, after controlling for initial status on FPS and kindergarten total reading scores on the Aprenda-3 Preprimario 2. This finding clearly and strongly indicates that acquiring the alphabetic principle is an important skill in early reading in Spanish. This finding is particularly important given that Spanish has a very transparent orthography and acquiring the alphabetic principle should not, in theory, present major problems for students.

In the next section we will discuss these results in the context of reading programs in Spanish-speaking countries. Then, we consider how this study can support a Response to Intervention system where the focus is on differentiated instruction for students who are struggling readers in the early grades.

Significance of this study for teaching decoding in Spanish

Current reading programs in many Spanish-speaking countries are based either on a whole language approach or on a phonics approach (Jiménez & O'Shanahan Juan, 2008). Studies in Spain indicate that students who learn to read through a whole language approach make more mistakes in pseudoword reading and spelling than students who learn to read using a phonics approach (Jiménez, Artiles, Muñetón, Díaz, & O'Shanahan Juan, 2002; Jiménez & Guzmán, 2003; Jiménez, Guzmán, & Artiles, 1997).

Although we don't want to dismiss the importance of teaching comprehension and vocabulary early (an emphasis in whole language approaches), the results of the current study indicate that learning to decode also provides a strong foundation for text comprehension. This is particularly important given recent assessment results in reading in Spanish-speaking countries. For example, in Mexico in 2007, only 30% of third graders were reading at a level of good or excellent according to the ENLACE national reading assessment test (http://enlace.sep.gob. mx/ba/?p=resultadosant). In Spain, recent international reading assessments indicate that students are reading below average compared to other countries in the OCDE (Jiménez & O'Shanahan Juan, 2008). In the United States, where about 50% of Spanish-speaking English learners attend a Spanish program (either in a transition model or a bilingual model, (Goldenberg, 2008), results on the NAEP 2007 reading assessment in English indicate that Spanish-speaking fourth graders lag, on average, 30 points behind their English counterparts. Although these results are in English, the students' second language, our experience working in schools providing a Spanish reading program, is that most Spanish reading programs (and these programs are common throughout the US) teach students to read using a whole language approach (where students learn to read words by sight), usually after a short introduction to Spanish syllables.

It is difficult to say whether the reason for lower scores on reading outcomes across Spanish-speaking countries and in the United States is caused largely by lack of proficiency with the alphabetic principle. However, reading difficulties in the later grades are clearly partially a consequence of reading difficulties in the early stages of reading development, when students are mastering the foundations of learning to read (Jiménez & O'Shanahan Juan, 2008). Research in the United States indicates that early reading interventions that focus on teaching students decoding skills, in addition to explicit instruction in vocabulary and comprehension, have a substantial effect on later reading outcomes (NRP, 2000). Snow, Burns, & Griffin (1998) state that, «a person who is not at least a modestly skilled reader by the end of third grade is quite unlikely to graduate from high school» (p. 21). Our study indicates that student knowledge of the alphabetic principle in Spanish has a significant positive effect on reading comprehension.

The role of growth on pseudoword reading in a Response to Intervention Model (RtI)

To implement an RtI model effectively, it is necessary to screen and progress monitor students with valid and reliable measures that are standardized, economic, and brief. Information from these measures can be used to determine the instructional support needed for each student to meet end of year reading goals. These screening tools should index each student's reading performance and inform educators if that student is at risk of future reading difficulties or on track for future reading success.

Students who are at a higher level of risk for future reading difficulties should be provided with a higher level of instructional support. Results of this study indicate that a pseudoword reading measure like FPS can effectively and efficiently screen and progress monitor student growth in acquiring the alphabetic principle. Students whose initial screening score on FPS indicate potential learning difficulties can be provided with additional interventions in small groups (Tier 2 support). If students do not progress after a reasonable amount of time during the tier 2 intervention (and it can be confirmed that the tier 2 intervention is taught effectively), they should receive more intensive assistance (Tier 3 support). Knowing how much growth on pseudoword reading can be expected of a first grader learning to read in Spanish helps educators determine the level of support this student will need. This study indicates that on average, students can learn 35 letter-sounds in a three-month period, from the middle of kindergarten to the end of first grade, excluding the summer months. Learning less letter-sounds would be one indication that additional instructional support is needed.

Our study confirms findings from earlier studies on the acquisition of automaticity in word reading. It is plausible for students learning to read in a transparent orthography like Spanish to master the alphabetic principle by the end of first grade, establishing the foundation needed to meaningfully reduce the gap between good readers and poor readers. This study also provides guidelines on how much growth we can realistically expect from a student learning to read in Spanish in the early grades.

Our research was conducted in the United States in schools with a large population of students on free and reduced lunch, and with students who were learning to read in a paired bilingual program. Future research should include a population of students learning to read in Spanish in Spanish-speaking countries using a research-based approach to instruction. If our findings are replicated, then a basis for developing a Response to Intervention system, where struggling readers are provided with effective interventions to accelerate their reading growth, can be initiated. The major purpose of this type of system would be to ensure that Spanish-speaking students become strong readers in their native language.

Acknowledgements

Appendix
Hierarchical multivariate linear model for Spanish pseudoword reading growth

Level-1 Model

$$Y_{ri} = \sum_{t=1}^{5} m_{tri} Y_{ti}^*$$

$$Y_{ti}^* = \pi_{0i} + \pi_{1i} (\text{Time Point})_{ti} + \pi_{2i} (\text{Summer})_{ti} + e_{ti}$$

where

Y_{ri} is the r-th outcome for student i associated with observation t;

m_{tri} is the indicator variable taking on a value of 1 if the r-th measurement for student i did occur at observation t, 0 if not.

Y_{ti}^* is the FPS score for student i at observation t for a multivariate model;

π_{0i} is the initial score of FPS for student i;

π_{1i} is the growth rate of FPS for student i;

π_{2i} is the summer drop in FPS between the end of kindergarten and the beginning of first grade for student i;

e_{ti} is the within person residual.

Level-2 Model

$$\pi_{0i} = \beta_{00} + u_{0i}$$

$$\pi_{1i} = \beta_{10} + u_{1i}$$

$$\pi_{2i} = \beta_{20}$$

where

β_{00} is the average initial score of FPS across all students;

u_{0i} is the unique effect of student i on the initial score;

β_{10} is the average growth rate of FPS across all students;

u_{1i} is the unique effect of student i on the growth rate.

β_{20} is the average summer drop in FPS across all students.

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