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The Gap Between Spanish-speakers' Word Reading and Word Knowledge: A Longitudinal Study

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Abstract

This longitudinal study modeled growth rates, from age 4.5 to 11, in English and Spanish oral language and word reading skills among 173 Spanish-speaking children from low-income households. Individual growth modeling was employed using scores from standardized measures of word reading, expressive vocabulary, and verbal short-term language memory. The trajectories demonstrate that students' rates of growth and overall ability in word reading were on par with national norms. In contrast, students' oral language skills started out below national norms and their rates of growth, although surpassing the national rates, were not sufficient to reach age-appropriate levels. The results underscore the need for increased and sustained attention to promoting this population's language development.

While native speakers of English spend several years acquiring oral language skills before formal reading instruction begins, non-native English speaking children—language minority (LM) learners—are charged with the challenging task of acquiring word reading skills while simultaneously developing oral proficiency in English. Their language background, coupled with their demographics, place this population at significant risk for academic failure and highlight the need for attention to research designed to shed light on how to meet their needs.

Latino students from Spanish-speaking homes comprise the largest and fastest growing segment of the school-aged population (Fry & Gonzales, 2008; Planty et al., 2009); from 1990 to 2006, Latino students accounted for 60% of the total growth in public school enrollments (Fry & Gonzales, 2008). The large majority of these children are U.S.-born (Fry & Gonzales, 2008; Hernandez, Denton, & Macartney, 2008) and are thus instructed in U.S. classrooms upon school entry. However, 70% report speaking Spanish at home (Fry & Gonzales, 2008). These learners disproportionally live in poverty (Fry & Gonzales, 2008; Hernandez et al., 2008) and show a striking gap in reading comprehension achievement when compared to native English speakers (for a review, see August & Shanahan, 2006). For example, on the fourth grade NAEP, 50% of Latino students scored at the *below basic* level in reading, compared to 22% of their White classmates. Moreover, Latinos account for nearly half (46%) of all high school dropouts (Snyder, Dillow, & Hoffman, 2007).

In spite of the evidence—derived primarily from cross-sectional research—that LM learners struggle academically, few studies provide insight into the patterns of development in word reading and oral language skills known to support reading comprehension outcomes. In turn, our knowledge of the extent to which rates of growth in key component skills for this

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growing population of at-risk learners will allow them to catch up to typically developing monolinguals (i.e., national norms) is limited.

Designed to advance the theoretical and empirical base focused on LM learners' reading development, and to inform effective instructional efforts, the present longitudinal study investigates Spanish-speaking LM learners' English and Spanish word reading and oral language skills from early childhood (age 4.5) through preadolescence (age 11). This study provides a unique opportunity to identify patterns of development, across two languages and across developmental stages, in skills known to support reading comprehension, providing a timely contribution to the field in light of current demographic shifts.

Key Reading Comprehension Skills: Word Reading and Oral Language

Research on the development of reading abilities has largely focused on native English speakers (e.g., Adams, 1990; Chall, 1996). This work has advanced our understanding of skills related to reading and their relative contributions to later reading comprehension outcomes. For example, there is consensus that students must be able to decode words (i.e., word reading), while simultaneously accessing word meanings (i.e., vocabulary knowledge). Of particular relevance to the LM learner population are the documented developmental shifts, over time, in the relative contributions of word reading and oral language skills to reading comprehension outcomes.

That is, in the primary grades, word reading accuracy and fluency are strong predictors of performance on reading comprehension measures (Adams, 1990; Chall, 1983, 1996; Francis, Fletcher, Catts, & Tomblin, 2005; Perfetti, 1985). However, as early as the preschool years, low vocabulary scores have been documented, suggesting that, alongside instruction on the code, early instruction must focus explicitly on the development of language skills (Dickinson, McCabe, Anastasopoulos, Peisner-Feinberg, & Poe, 2003). Notwithstanding, during these years, reading instruction typically emphasizes word-level reading skills and the texts for age-appropriate reading feature high frequency, basic vocabulary. After the primary grades, the text students read includes more sophisticated language and oral language skills become the primary source of variability in predicting reading comprehension outcomes (Anderson & Freebody, 1983; Catts, Hogan, & Adlof, 2005; RAND Reading Study Group, 2002; Vellutino, Tunmer, Jaccard & Chen, 2007). Given that oral language skills play an increasingly important role over time in reading comprehension achievement, students must not only attain adequate word reading skills but their oral language skills must also continue to develop (Paris, 2005; Snow & Kim, 2007).

These developmental processes associated with reading comprehension outcomes have implications for LM learners' academic outcomes. While native English speakers' development in the language of schooling begins in infancy, for many LM learners this process only begins upon school entry. Moreover, it has been widely documented that income status and quantity of language exposure have significant effects on later language (e.g., Hart & Risley, 1995) and reading comprehension outcomes (e.g., National Research Council, 1998). Thus, children who come from homes in which English is not the primary home language—a disproportionate number of whom are living in poverty—are at increased risk for reading comprehension difficulties. Despite the fact that the majority of LM learners are typically able to develop adequate word reading skills, their oral language skills, and in turn reading comprehension scores, are significantly lower than the national average (for a review, see Lesaux, 2006). However, questions remain about the patterns of growth of these key component reading skills—questions that can only be answered via longitudinal studies that track development in these domains. The present study seeks to contribute to the research base by identifying patterns of development in LM learners' word reading and oral language skills across childhood, relative to typically developing monolinguals (i.e., national norms of standardized measures).

Developmental Patterns in Reading and Oral Language

Longitudinal work with native English speakers suggests that LM learners' growth in word reading and oral language skills is likely to follow a positive and consistent rate of development (i.e., to be linear) through the end of the primary grades. For example, Compton (2000) found growth in word reading skills from the beginning to the end of first grade to follow a linear trajectory. Jordan, Kaplan, and Hanich (2002) similarly found growth in word reading to be linear from second to third grade. The more recent Home-School Study findings of Snow, Porche, Tabors, and Harris (2007) also show that, among their sample of children from low-income homes, receptive vocabulary (kindergarten to sixth grade), academic language (first to fourth grade) and word reading (first to fourth grade) skills increased with each successive school grade. However, among their sample of kindergarteners followed through third grade, Speece, Ritchey, Cooper, Roth, and Schatschneider (2004) report that growth in word reading varied with time as students initially exhibited linear growth, but growth slowed over time. Similarly, Francis, Shaywitz, Stuebing, Shaywitz, and Fletcher (1996) found that, from childhood to adolescence, growth in reading (composite of real and pseudo-word reading and passage comprehension) was not constant, such that, after initial rapid linear growth during childhood years, students' reading skills slowed around age 15 (grade 9). Catts, Bridges, Little, and Tomblin (2008) also examined reading growth for two groups of monolingual English speakers—children with language impairments and typically developing children, assessed at second, fourth, eighth, and tenth grade. Like Snow and colleagues, Catts and colleagues found growth in word reading to be linear. However, after high initial acceleration, both groups showed slower growth during the middle and high school years, which the authors assert is consistent with the slowing pattern reported by Francis and colleagues.

Thus, studies with native English speakers show growth in reading skills to be linear through the end of the primary grades, with growth beginning to slow as students enter the high school years. With the exception of the findings from the Home-School Study (Snow et al. 2007), these studies have focused exclusively on word reading. Prior research has not modeled growth in oral language skills despite the well-established link between these skills and reading comprehension (e.g., Anderson & Freebody, 1981; Stanovich, Cunningham, & Feeman, 1984).

Four studies conducted with Spanish-speaking LM learners in the U.S. begin to shed light on their word reading and oral language skills. Gerber and colleagues (2004) found patterns of development in word reading skills from kindergarten through first grade among Spanish-speaking children from low-income homes, instructed in English, to be linear. Swanson, Saez, and Gerber (2006) similarly identified linear growth from first to third grade in word reading skills, as well in receptive vocabulary, for a sample of Spanish-speaking LM learners instructed in English. More recently, Hammer, Lawrence, and Miccio (2008) reported that Spanish-speaking LM learners exhibit linear receptive vocabulary growth across two years in Head Start. Finally, Nakamoto, Lindsey, and Manis (2007) found English word reading development among Spanish-speaking LM learners followed from first through sixth grade to be initially linear, with growth slowing by fifth grade.

Despite the documented low oral language achievement levels among LM learners across different developmental stages (for a review, see Lesaux, 2006), only two of these studies (Hammer et al., 2008; Swanson et al., 2006) examined development in oral language among this population, in this case receptive vocabulary development in the preschool and primary grades. Low levels of vocabulary knowledge have repeatedly been identified as a key impediment to successful comprehension among LM learners (Garcia, 1991; Nagy, 1997; Stahl & Nagy, 2006) and previous work has typically measured oral language skills using vocabulary tasks (whether receptive or expressive). In the present study, a measure of expressive vocabulary was used.

Yet, knowing the meanings of words represents only one, albeit a highly important, component of oral language. Vocabulary acquisition inherently involves the ability to retain words in memory (for a detailed account of this hypothesized relationship, see Gupta & MacWhinney, 1997) and the ability to repeat sentences, which taps both memory and sentence processing, is strongly correlated to future reading achievement (Scarborough, 1998). Thus, in addition to vocabulary tasks, immediate sentence recall tasks (i.e., verbal short-term language memory) might provide a more complete understanding of students' oral language skills, tapping into both semantic and syntactic knowledge (Allen & Baddeley, 2009). To our knowledge, studies to date have not documented patterns of growth in verbal short-term language memory. Additionally, even though LM learners are by definition exposed to a language other than English at home, at least to some extent, studies to date have not investigated developmental patterns in native language skills.

By concurrently modeling growth rates in Spanish and English word reading and oral language skills (i.e., vocabulary and verbal short-term language memory) from early childhood through preadolescence, the present study provides unique insight into the extent to which LM learners can be expected to catch up to typically developing monolinguals (as determined by national norms from standardized, norm-referenced measures) as they transition through different developmental periods. The sample is comprised predominantly of U.S.-born children of immigrants from low-income households who primarily experienced all-English instructional environments beginning as early as age 4.5. These children are representative of the great majority of LM learners enrolled in U.S. classrooms (U.S. Department of Education, 2010; Zehler, Fleischman, Hopstock, Stephenson, Pendzick, & Sapru, 2003). Two specific research questions guided this study:

1) What are the patterns of development of students' Spanish and English word reading and oral language skills from age 4.5 to 11?

2) How do students' rates of growth compare to national norms in each language?

Research to date with LM learners provides a solid foundation for two hypotheses: their word reading skills will grow at rates comparable to national norms, whereas their oral language skills will lag behind national norms. Additionally, given students' English instructional environments, we hypothesized that students' Spanish word reading and oral language growth rates would be lower than rates in English.

Method

Study Design

Three-hundred and eighty-seven families were recruited for participation from 14 Head Start programs and 2 public preschool programs in the Northeastern U.S during the 2001–2002 academic year if they reported Spanish as the primary language of the home, even if the children themselves spoke English. Thus, as a group, we refer to the participants as language minority (LM) learners. Participating children were followed from age 4.5 to 8[1]. One-hundred and seventy-three families were then re-recruited into the study at 11 years of age[2].

[1]The bulk of families (n = 316) were recruited into the study when children were in the fall of their preschool year (age 4.5). However, to account for attrition and for research-practice partnership reasons, an additional 71 families were included when children were in the spring of that academic year (age 5), resulting in a total of 387 recruited families when during their child's preschool year.

At follow-up, students attended 75 schools in the Northeastern U.S. and, reflecting recent national trends, nearly all students (95%) had been educated in English-only classrooms[3]. There were no significant differences in key demographic characteristics and in Spanish and English language and literacy skills between the children who were and were not recruited for participation at follow-up (see Appendix A).

Participants

A parent phone interview was administered at study entry and at follow-up to gather data on demographics and language use. At both time points, over 90% of the interviewees were mothers. All children had mothers in the household; a sizeable group of children (30% at study entry and 37% at follow-up) did not have a father in the household. Thus, we report on maternal demographic characteristics. The interview was adapted from a demographic questionnaire developed by the Development of Literacy in Spanish Speakers (DeLSS) project and was prepared in Spanish and English. The great majority of children (89%) were born in the U.S., and nearly all parents (97%) identified their children as Latino. In contrast, the great majority of mothers (89%) were born outside of the U.S. mainland, primarily in the Dominican Republic, Puerto Rico, and El Salvador. Although there was some variation in maternal education, 36% of mothers had less than a high school education and only 8% completed a four-year college program (of these, 2 completed some graduate school and 1 completed graduate school). Furthermore, 82% of families were low-income, with 52% living in deep poverty or in poverty.

Parents also responded to questions about language use in the home at study entry and at follow-up. At study entry, 47% of parents or guardians reported using only or mostly Spanish at home with children, compared with 22% at age 11. None of the children received all of their input in English at age 4.5 and only 3 children (2%) did so at age 11. Parents reported a shift toward more English and less Spanish use by the children themselves over time; at age 4.5, 45% used only or mostly Spanish at home with their families, compared to 17% at age 11. Eighty-seven percent of children heard at least some English in the households by age 4.5, with nearly all (92%) using some English themselves even by this early age. Thus, children in this study were effectively in mixed-language environments, with Spanish and English exposure and use at home through age 11.

Finally, from state websites, we obtained information on students' school characteristics for the 2007–2008 year. Nearly all students (96%) were enrolled in public schools, with the majority (83%) receiving Title I funds, designated for schools with high percentages of children from low-income families. In these schools, on average, 66% of students were from low-income households and 80% were from minority backgrounds (58% Latino). On average, 52% of all students in these schools scored in the *needs improvement* or *warning/failing* category on the state English Language Arts and Mathematics test. To compare to national rates, 90% of Latino students attend public schools, with an average minority enrollment of 41% (30% Latino in Central city locales), 73% attend low-income schools, nearly half (49%) attend schools where more than 75% of the students are eligible for free/reduced lunch, and over half (58%) attend schools where there is a 75%+ concentration of minority students (KewalRamani, Gilbertson, Fox, & Provasnik, 2007). Further, 50% of Latino 4th graders score *below basic* in reading (Lee, Grigg, & Donahue, 2007) and 29% do

[2]Children with full data (i.e., word reading, vocabulary and verbal short-term language memory) at 2 or more time points were targeted for recruitment at follow-up. Of the 173 successfully recruited children, 7 did not have full data in the spring of preschool. Thus, the largest sample size is at age 11 rather than at age 5 (the final time point for recruitment at study entry). Note that of the 173 recruited children, 19 had been retained one academic year. However, there were no significant differences in Spanish and English language and literacy skills (p>.05).

[3]There were no significant differences in English and Spanish language and literacy skills (p>.05) between the 9 children who were bilingually instructed, compared to the 164 children instructed only in English.

so in mathematics (NCES, 2009). The characteristics of the schools LM learners attend are thus representative of U.S. national trends.

Procedure

Children were individually tested at six time points: ages 4.5, 5, 6, 7, 8, and 11 (see Table 1 for testing ages). Seven college-educated Spanish-English bilingual research assistants were trained to administer the individual assessments in a quiet room at the children's schools, homes, in community libraries, or after-school programs. Children received a $10 gift card to thank them for their participation.

Measures

Measures of children's language and literacy development were obtained in both Spanish and English using direct standardized assessments. Expressive vocabulary, verbal short-term language memory, and word reading skills in Spanish and English were assessed using the Woodcock Language Proficiency Battery- Revised (WLPB-R; Woodcock, 1991; Woodcock & Muñoz-Sandoval, 1995). The Spanish form was adapted from the parallel English form, both normed on monolingual populations, and thus both forms measure the same abilities. Importantly, however, each form contains unique item content, allowing scores from the two tests to be compared without concerns that experience with the content of the test in one language will improve performance in the other language. The test developers equated the Spanish norms to the English norms on difficulty using Rasch model techniques, facilitating cross-language comparisons.

Oral Language Skills

Vocabulary—Vocabulary was assessed with the Expressive Vocabulary subtest from the WLPB-R (Woodcock, 1991; Woodcock & Muñoz-Sandoval, 1995). Children named pictured objects that were ordered by increasing difficulty. The task is discontinued when the child fails six consecutive items. The publisher reports median internal consistency reliability coefficients of .91 for the Spanish version and .86 for the English version.

Verbal Short-Term Language Memory—Verbal short-term language memory was assessed with the Memory for Sentences subtest from the WLPB-R (Woodcock, 1991; Woodcock & Muñoz-Sandoval, 1995). Children heard and then repeated a word/phrase/sentence(s). The task is discontinued when the child misses four consecutive items. The publisher reports median internal consistency reliability coefficients of .88 for the Spanish version and .90 for the English version.

Word Reading

Word Reading—Word reading was assessed with the Letter-Word Identification subtest from the WLPB-R (Woodcock, 1991; Woodcock & Muñoz-Sandoval, 1995). Children read a list of real words of increasing complexity. The task is discontinued when the child misses six consecutive items. The publisher reports median internal consistency reliability coefficients of .91 for the Spanish version and .92 for the English version.

Analytic Approach

To examine patterns of development in vocabulary, verbal short-term language memory, and word reading skills, we used Individual Growth Modeling (IGM) using the multilevel model for change (Singer & Willett, 2003), with age in months used to index time. The analyses were conducted in a person-period dataset that contained the longitudinal data on all sampled children, using SAS PROC MIXED with full maximum likelihood estimation. The use of IGM allows for robust estimates of growth even with occasional missing or incomplete data points for individual children, which is important for a longitudinal study. Further, in addition to providing estimates of initial status at the first point of measurement on a particular variable (e.g., oral language, word reading), IGM allows for the examination of the rate of change on a particular variable, the variability in the rates of change, and also focuses on how rates of growth may be related to status at the initial point of measurement.

To specify a functional form that best described the patterns of growth in children's vocabulary, verbal short-term language memory, and word reading skills in both languages based on the WLPB-R (Woodcock, 1991; Woodcock & Muñoz-Sandoval, 1995), empirical growth trajectories were examined and a series of baseline models (unconditional means and unconditional growth) with various parameterizations of time were compared to one another. The parameterization of time (e.g., linear or quadratic) determines the functional form of the model. The unconditional means model serves as a baseline model against which the unconditional growth model is compared. As suggested by Singer and Willett (2003), the likelihood ratio test was used as the primary criterion for evaluating model fit, and the Akaike and Bayesian information criteria are also provided as additional indicators of goodness of fit. For the outcome variable measuring growth, we used the W-score, a developmental scale score for the WLPB-R that has been vertically equated using Item Response Theory. The W-score indexes absolute growth rather than growth relative to the norm, which is essential for studying inter-individual differences in change over time. The W-score is scaled such that a score of 500 corresponds to the performance of an average 10-year-old. For all models, residuals were examined to confirm that the assumptions of linearity, normality, and homoscedasticity were adequately met.

We used two strategies to interpret students' oral language and word reading growth in English and Spanish, compared to national norms. First, to quantify the absolute magnitude of the observed differences (i.e., gaps) in their oral language and word reading performance using a standardized metric, we calculated effect sizes at all time points by dividing the mean difference by the standard deviation of the national norms. We were thus able to determine how many standard deviations the means of the LM learner sample were apart from the national norming sample and this allowed us to interpret differences using Cohen's (1992) conventions for effect sizes (i.e., .2 is considered a small effect, .5 is a medium effect, and .8+ a large effect). Next, we calculated the actual increase in W-score points over the time period under study (age 4.5–11) to determine the increase students would have needed to be on par with national norms.

Results

Preliminary Descriptive Analyses

Table 2 displays students' English and Spanish W-scores, alongside corresponding standard scores to facilitate interpretation concerning their relative achievement levels, on the three measures across all time points (age 4.5 to 11). As indexed by the sample mean, English word reading skills were within the average range at each time point. On the English measure of verbal short-term language memory, the sample scored about 1.5 standard deviations below the average range from age 4.5 to 6, and then scores were in the low-average range from age 7 to 11. In contrast, students' English vocabulary skills were below the average range across all time points, with the exception of age 11 when the mean standard score fell just within the average range, at the 17^{th} percentile. In Spanish, students' word reading skills hovered near the average range across all time points, but their oral language skills (i.e., vocabulary and verbal short-term language memory) were about two or more standard deviations below the average range at all time points. As Table 2 shows, there are different patterns of growth from age 4.5 to 11. For example, the English vocabulary gain in W-score units from age 7 to 8 (a one year time frame) is 9.7 while the gain from age 8 to 11 (a three year time frame) is only 18.9, suggesting a non-linear pattern of development.

Growth Modeling Results

Inspection of empirical growth plots of each child's English and Spanish vocabulary, verbal short-term language memory, and word reading scores as a function of age suggested curvilinear growth trajectories, with growth slowing over time, as suggested based on examination of students' mean scores from age 4.5 to 11 (see Table 2). Thus, we determined that a quadratic growth specification would be most appropriate for representing the individual developmental trajectories on all three skills. This multilevel model for change expressed in composite form is:

$$ESVocab\_ESVerbalSTM\_SWordRd_{ij}=\left[\gamma_{00}+\gamma_{10}(Child\,Age-55)_{ij}+\gamma_{20}(Child\,Age-55)^2_{ij}\right]+\left[\zeta_{0i}+\zeta_{1i}\,(Child\,Age-55)+\varepsilon_{ij}\right]$$

where $\varepsilon_{ij} \sim N\left(0,\sigma^2_\varepsilon\right) and \begin{bmatrix} \zeta_{0i} \\ \zeta_{1i} \end{bmatrix} - \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}\begin{bmatrix} \sigma^2_0\sigma_{01} \\ \sigma_{10}\sigma^2_1 \end{bmatrix}\right)$

The subtraction of 55 from child age allowed for a meaningful interpretation of the parameter estimates: γ_{00} represents the average score for children at age 55 months (the first measurement point), γ_{10} represents the average true initial, instantaneous slope, and γ_{20} represents the average true acceleration. The random effect ε_{ij} is a level-1 residual for child *i* at time *j* and is assumed to be drawn from a normal distribution with mean of 0 and unknown variance σ^2_ε. Random effects ζ_{0i} and ζ_{1i} represent level-2 residuals for the intercept and slope, respectively. They are both hypothesized to be drawn from a multivariate normal distribution with a mean of zero, unknown variances σ^2_0 and σ^2_1, and unknown covarianceσ_{01}.

The only exception to the model specification presented above involved the English word reading model. Inclusion of the random effect associated with growth resulted in the error-covariance matrix not being positive definite, indicating that there was minimal variation across children's English word reading skills. We thus simplified the model by removing the random effect associated with growth. This strategy assumes that error is equivalent across individuals, and allowed us to specify the functional form for English word reading growth rates (Singer & Willett, 2003). Thus, the English multilevel model for change expressed in composite form is:

$$EWorbRd_{ij}=\left[\gamma_{00}+\gamma_{10}(Child\,Age-55)_{ij}+\gamma_{20}(Child\,Age-55)^2_{ij}\right]+\left[\zeta_{0i}+\varepsilon_{ij}\right]$$

where $\varepsilon_{ij} \sim N\left(0,\sigma^2_\varepsilon\right) and\, \zeta_1 \sim N\left(0,\sigma^2_\zeta\right)$

Tables 3, 4, and 5 present the results of a series of multilevel models fitted to represent students' English and Spanish vocabulary, verbal short-term language memory, and word reading growth. The inclusion of the quadratic term improved model fit on all three skills: English vocabulary (Δ-*2LL* = 216.4; *df* = 1, *p* < .001), Spanish vocabulary (Δ-*2LL* = 69.4; *df* = 1, *p* = <.001), English verbal short-term language memory (Δ-*2LL* = 199.8; *df* = 1, *p* < .001), Spanish verbal short-term language memory (Δ-*2LL* = 42.5; *df* = 1, *p* < .001), English word reading (Δ-*2LL* = 220.9; *df* = 1, *p* < .001), and Spanish word reading (Δ-*2LL* = 19.1; *df* = 1, *p* < .001). The significant (positive) linear terms indicate that, on average, the rate of change in students' oral language and word readings skills in both languages is positive (i.e., there is improvement), and the significant (negative) quadratic terms indicate that the rate of improvement decreases as students get older (i.e., the rate of change is not constant).

The use of IGM allowed for an examination of variability in individual patterns of change, as well as in patterns of change across individuals. The Level 1 variance components, all statistically significant, indicate that LM learners differ in their own oral language and word reading levels from one occasion to the next (e.g., age 6 to 7). As noted, for English word reading, we removed the quadratic term associated with growth as there was minimal variability across students' English word reading skills. However, the Level 2 variance components for English and Spanish vocabulary, English and Spanish verbal short-term language memory and Spanish word reading revealed variation across students' initial (age 4.5) levels of performance and, except for Spanish verbal short-term language memory, also across their rates of growth from age 4.5 to 11. Finally, the estimated covariance is negative for English oral language skills, indicating that LM learners who started (age 4.5) with higher English oral language experienced a slower rate of English oral language growth. In contrast, the estimated covariance for students' Spanish vocabulary and word reading is positive, indicating that LM learners who started (age 4.5) with higher Spanish vocabulary and word reading levels experienced a faster rate of growth in these skills. Below, we describe LM learners' specific patterns of development in each of the three skills assessed, relative to national norms.

Vocabulary Growth—As Models EV3 and SV3 in Table 3 show, the rate of deceleration is the same in English and in Spanish ($\gamma_{20} = -0.01$, $p<.001$). However, LM learners started (age 4.5) with higher English ($\gamma_{00} = 430.4$, $p<.001$) than Spanish ($\gamma_{00} = 422.8$, $p<.001$) vocabulary levels and the mean linear slope was also higher in English ($\gamma_{10} = 1.3$, $p<.001$) than in Spanish ($\gamma_{10} = 0.9$, $p<.001$). Growth begins to decelerate at age 10 in English and at age 8 in Spanish. By age 11, English vocabulary remained higher than Spanish vocabulary.

Figure 1 displays the English (long dashed line) and Spanish (short dashed line) vocabulary fitted growth trajectories for students in this study compared to the national norms (solid black line). The differences in standard deviation units at each of the six time points, expressed as effect sizes, are presented along the x-axis. As the figure shows, in English, LM learners started out well below national norms at age 4.5 (average effect size 1.8) and although the gap narrowed at about age 8 (average effect size 0.9), LM learners' English vocabulary remained below national norms by age 11 (average effect size 1.0). In Spanish, and as previously noted, LM learners' vocabulary level at age 4.5 was lower than their English vocabulary and thus even further below national norms (average effect size 2.3). Further, the lower mean linear slope in Spanish compared to English resulted in the growth rate in English outpacing the growth rate for Spanish vocabulary, with the average effect size being very large (3.4) by age 11. The growth rate comparison revealed the enormity of the vocabulary task faced by these LM learners.

The national absolute increase during this time period is 46 W-score points; although LM learners' average absolute increase in English vocabulary was higher (60 W-score points), their English vocabulary would have had to show a much larger increase (75 W-score points) to catch up to national norms. In Spanish, students' absolute increase during this time period was much lower (34 W-score points) than the national increase. Specifically, students' Spanish vocabulary would have had to increase by nearly three times as much (82 W-score points) to catch up to national norms.

Verbal Short-Term Language Memory Growth—As Table 4 shows (see Models EM3 and SM3), LM learners' initial (age 4.5) verbal short-term language memory levels were about the same in English (γ_{00} = 440.8, p<.001) and Spanish (γ_{00} = 436.9, p<.001). Although the rate of deceleration was faster in English (γ_{20} = −0.01, p<.001), compared to Spanish (γ_{20} = −0.004, p<.001), the mean linear slope was notably higher in English (γ_{10} = 1.2, p<.001) than in Spanish (γ_{10} = 0.6, p<.001). Thus, even though growth begins to decelerate at age 9.5 in English and at age 10.5 in Spanish, by age 11, LM learners' English verbal short-term language memory level was much higher than their Spanish verbal short-term language memory level.

Figure 2 displays the English (long dashed line) and Spanish (short dashed line) verbal short-term memory fitted growth trajectories for students in this study compared to the national norms (solid black line). As previously noted, LM learners' verbal short-term language memory levels were about the same in English and Spanish and they both fell well below national norms at age 4.5 (average effect size 1.5 and 1.8, respectively). As the figure shows, students' English verbal short-term language memory skills improved over time, with the gap narrowing by age 8 (average effect size .6), but widening again by age 11 (average effect size .8). In Spanish, because the mean linear slope was much lower (compared to English), the rate of Spanish verbal short-term language memory deceleration did not offset the growth rate in this skill. Indeed, by age 11, the average effect size was very large (2.9).

The national absolute increase in verbal short-term memory is 38 W-score points. Even though the average absolute English increase for LM learners was slightly higher (49 W-score points), because they started so low, students needed to show a faster increase (61 W-score points) to catch up to national norms. With an absolute increase of only 19 W-score points, students' Spanish performance was substantially lower than the national average, evidenced by the increasing sizes of the gaps. The absolute increase in verbal short-term language memory would have had to be more than three times as large (57 W-score points) to catch up to national norms.

Word Reading Growth—Models EW3 and SW3 in Table 5 show that LM learners' initial (age 4.5) word reading levels were higher in English (γ_{00} = 356.0, p<.001) than Spanish (γ_{00} = 350.2.9, p<.001). Further, even though the rate of deceleration was faster in English (γ_{20} = −0.02, p<.001), compared to Spanish (γ_{20} = −0.01, p<.001), the mean linear slope was higher in English (γ_{10} = 3.3, p<.001) than in Spanish (γ_{10} = 2.1, p<.001). Of note, unlike oral language, LM learners' word reading growth does not begin to decelerate in either language through age 11.

Figure 3 displays the English (long dashed line) and Spanish (short dashed line) word reading fitted growth trajectories for students in this study compared to the national norms (solid black line). As the figure shows, in English, LM learners started out below national norms at age 4.5 (average effect size 0.5). By age 5, however, their word reading skills were essentially indistinguishable from national norms (average effect size 0.1) and they remained on par with national norms through age 11 (average effect size 0.04). In Spanish, and as previously noted, LM learners' word reading level at age 4.5 was slightly lower than in English and thus even further below national norms (average effect size .8). Further, and also as noted, the rate of deceleration was slightly lower in Spanish, but the mean linear slope was also lower. Thus, by age 8, the gap had widened (average effect size 1.4) and the effect size remained large by age 11 (1.1).

The national absolute increase in word reading was 135 W-score points. For LM learners, the average absolute English increase was higher (145 W-score points). Because they started below national norms, the higher absolute increase allowed them to remain on par with national norms by age 11. In Spanish, students' absolute increase was lower (124 W-score points), compared to national norms. To be on par with national norms, their absolute increase would have had to be higher than the national increase (153 W-score points).

Discussion

This study's findings, focused on identifying patterns of development in low-income, Spanish-speaking LM learners' English and Spanish word reading and oral language skills from early childhood through preadolescence, relative to national norms, reveal two striking gaps. The first gap demonstrates the sample's significant weaknesses in Spanish, relative to norms and relative to their English skills. Perhaps more importantly, with implications for how we think about the role of vocabulary for academic success and instruction, the second gap shows a striking discrepancy between students' ability to read words and their word knowledge in English.

As hypothesized, LM learners' word reading and oral language skills were stronger in English than in Spanish, even at age 4.5, and they remained this way through age 11. However, the magnitude of the gap relative to the national average, particularly in the oral language domain, was unexpected; at age 11, Spanish oral language skills had not reached the equivalent of a four-and-a-half-year-old monolingual speaker. To interpret these results, we draw the reader's attention to the sample characteristics. As noted, the LM learners in this study were recruited from preschool programs in the Northeastern U.S. during the 2001–2002 academic year, a time when, due in part to legislation in the late 1990's and early 2000's, English-only instruction became increasingly prevalent (for a discussion, see Ovando, 2003). Given this, 95% of the study participants received all of their instruction in English. Further, and somewhat related, families were recruited if they reported Spanish as the home language, even if children spoke English. Indeed, families reported that, even though Spanish continued to be used in the household through age 11, most children already used English themselves by age 4.5.

Our second finding—the discrepancy between English word reading and English oral language skills—is particularly troubling given students' English-only instructional experience and the strong relationship vocabulary has with reading comprehension outcomes. Our results converge with those of a recent review that finds the great majority of LM learners are able to develop word reading skills at rates similar to native speakers (Lesaux, 2006), and reinforce the status of word reading as a `constrained skill' rather than one that is multi-faceted in nature and that varies widely (Paris, 2005). In turn, while word reading skills are crucial for children to allocate needed resources to comprehension-related processes (National Research Council, 1998), such as accessing word meanings, they are a necessary but not sufficient skill for literacy proficiency. In fact, text comprehension will not exceed general language ability despite the development of accurate word reading skills (e.g., Tunmer & Hoover, 1993), underscoring the importance of oral language for understanding LM learners' poor reading outcomes.

LM learners' patterns of growth in oral language thus suggest a developmental lag, relative to national norms. By coupling the vocabulary measure with the verbal short-term language memory task, we were able to attain greater insight, above and beyond vocabulary knowledge, into LM learners' language abilities. Students' development on the verbal short-term language memory task indicate that these LM learners were challenged by the task of recalling sentences of increasing complexity, from simple constructions to more syntactically complex ones, reflecting limitations at the syntactic level. Given the role of vocabulary in verbal recall (Bialystok & Feng, 2009), students' low levels of vocabulary knowledge likely complicated the task of preserving the order of the words to reproduce sentences. On the one hand, the verbal short-term language memory task might be considered easier than the vocabulary task because, for the latter task, students were required to provide a name for the pictured objects whereas in the former they only had to repeat the words provided by the examiner. On the other hand, the task of verbally recalling increasingly complex phrases/sentences might have been more difficult as it required that students preserve both the syntactic and semantic relationships among the phrases/sentences while retaining the information in short-term memory. LM learners' patterns of development on the verbal short-term language memory task suggest that their reading problems will only be compounded because of the role short-term memory plays in both vocabulary acquisition and reading comprehension (e.g., Brown & Hulme, 1992; Swanson & Ashbaker, 2000).

In the following sections, we discuss the implications of these findings, theoretically and practically, with a focus on the need to be proficient in English for academic success in U.S. classrooms.

Implications

For LM learners, school often represents the first formal encounter with the English language. This means that, unlike native English speakers who have acquired knowledge of thousands of words prior to school entry (Anglin, 1993) and also knowledge of the English language structure (Daniels, 1998), LM learners must learn both basic and sophisticated vocabulary and linguistic structures, including syntactic knowledge, at an accelerated pace if they are to catch up to their native English speaking peers. The oral language skills that the students in the present study bring to the classroom represent a formidable impediment that will be compounded with increased language demands of text, especially in middle and high school, when the textbook and sophisticated literary texts are central to the curriculum (Bailey, 2007; Scarcella, 2003; Snow & Uccelli, 2009). In turn, students' language skills are intimately linked to their conceptual (background) knowledge and both are key predictors of reading comprehension outcomes (e.g., Anderson & Freebody, 1981; Anderson & Pearson, 1984; Droop & Verhoeven, 1998; Jiménez, García, & Pearson, 1996).

Because the sample of LM learners studied had been enrolled in U.S. schools since preschool, received their instruction in English, and their family discourse took place increasingly in English over time, their disconcertingly slow rate of development in the oral language domain has important implications for the design of instructional environments to better serve these learners. The children in this study, representative of a growing population of learners in today's classrooms (U.S. Department of Education, 2010; Zehler, Fleischman, Hopstock, Stephenson, Pendzick, & Sapru, 2003), need to be exposed to and explicitly taught more sophisticated vocabulary and more sophisticated language structures than has been the case. Estimates of words learned during a typical school year range from 1,000 (Goulden, Nation, & Read, 1990) to 3,000 (Nagy & Herman 1987), and research finds that, over time, students learn the bulk of the words that make up their vocabularies from reading (Fukkink & de Glopper, 1998; Stanovich & Cunningham, 1993). However, this is only possible if the reader meets a certain threshold of text comprehension, which relies heavily on vocabulary skills; the results of this study suggest that simply engaging these students in more reading would not be enough. Rather, while word reading skills are being developed in the primary grades, there must be a simultaneous emphasis on oral language development. Specifically, these findings underscore the need, as early as the preschool years, for a concerted focus on multi-faceted oral language instruction for the growing population of LM learners, many of whom enter school with limited English skills, in the service of promoting their general language ability as well as their reading comprehension skills. This is particularly the case since the schools the study participants attended are precisely those associated with low reading achievement and chronic underachievement (Lutkus, Grigg, & Donahue, 2007).

To compound matters, classroom language interactions tend to be largely restricted to basic patterns of everyday conversational English (e.g., Scarcella, 2003), with more basic vocabulary and more syntactically simple structures than are needed for text comprehension. It is thus imperative that instruction aim to bring the language of text to the classroom; while this topic has begun to receive increased attention in the reading community, investigations of what constitutes developmentally age-appropriate academic language instruction for LM learners are needed (for a discussion, see Scarcella, 2003).

In addition, results of this study provide implications for assessment, both the measures that are used and the frequency with which they are administered. Early literacy screening measures typically focus on the code (National Early Literacy Panel, 2008) and, as evidenced by students' word reading achievement levels beginning in early childhood, the LM learners in our sample would have done very well on code-focused early literacy screening measures, in spite of very low oral language skills, which will ultimately hinder their comprehension. Early literacy screening should focus on code- and meaning-based measures and children should be followed over time. By measuring their reading *and* language skills longitudinally, it is possible to monitor student progress, identify differentially developing patterns, and, most importantly, provide timely instructional supports that match readers' needs.

Limitations and Future Research

In considering the conclusions of this study as it relates to understanding second language acquisition, it is important to consider the demographics of the LM learners studied. This study focused on the large and growing population of LM learners from low-income homes and thus generalizations must be restricted to this specific population in light of the relationship between income status and language and reading development (for a discussion, see National Reading Panel, 1998). In turn, future research designed to investigate patterns of reading and language development for LM learners should consider at least one of two sampling strategies. Studies with LM learners from low-income backgrounds should include a comparative group of native English speakers from similarly low-income backgrounds. Somewhat related, to the extent that large, homogeneous samples of LM learners from middle- and upper-income backgrounds can be identified for longitudinal study, these studies should be conducted. These two designs would shed further light on LM learners' development of language and reading and, specifically, inform our understanding of the extent to which the slow patterns of development in oral language skills shown in this study, relative to national norms, are rooted in their low income status, or whether in fact students' language status is the more active ingredient in these developmental trajectories.

Additionally, the findings from present study revealed considerable variation within and across students in their patterns of reading and language development. Further research that examines the effects of time-varying predictors (e.g., language use in the home at different ages) and time-invariant predictors (e.g., phonological skills at school entry) might inform our understanding of sources of variability in LM learners' word reading and oral language development. Finally, the sample was limited to one geographic region of the U.S.—a region where English-only instruction predominates and where communities are generally English-speaking. Studies that include LM learners who have had formal opportunities to develop their native language and literacy skills, and who reside in enclaves that operate on the native language would shed further light on questions about developmental patterns of language and reading development as they relate to second language acquisition.

Practically speaking, LM learners' low oral language skills severely limit their ability to access grade-level curriculum, which in turn puts them at high risk of dropping out of school. Our results strongly suggest that, without increased attention to instruction to support the development of oral language skills beginning in early childhood, efforts to improve upon LM learners' literacy outcomes and high school graduation rates will be limited.

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Appendix A

Sample mean, standard deviation and statistics for testing differences in selected background variables and Spanish and English language and literacy skills at study entry between children who were (n = 173) and were not (n = 214) recruited for follow-up (age 11).

Variable	Mean (SD)		F-statistic (p-value)
	Followed through Age 11	**Not followed through Age 11**	
Income[a]	2.81 (1.76)	2.83 (1.70)	0.01 (0.92)
Mother's language use to child[b]	1.80 (1.05)	1.63 (0.90)	2.85 (0.09)
Child's language use to mother[b]	2.61 (1.28)	2.48 (1.19)	1.08 (0.30)
English vocabulary[c]	16.80 (4.57)	16.12 (4.71)	1.92 (0.17)
Spanish vocabulary[c]	13.47 (4.18)	13.80 (4.34)	0.54 (0.46)
English verbal short-term memory[c]	29.63 (5.03)	29.04 (5.07)	1.25 (0.26)
Spanish verbal short-term memory[c]	24.47 (6.62)	24.62 (6.63)	0.05 (0.83)
English word reading[c]	6.77 (3.37)	6.96 (3.44)	0.29 (0.59)
Spanish word reading[c]	4.80 (1.86)	5.00 (2.02)	1.01 (0.32)

Note. Parent interview data was not collected for five children at study entry. Mother-child language use is reported because a sizeable number of children (n=50) reportedly did not have a father in the home at study entry.

[a]1=income bracket under $10,000, 2=income bracket between $10,000–19,999, 3=income bracket $20,000–29,999

[b]1=Only Spanish, 2=Mostly Spanish, 3=English and Spanish Equally

[c]Woodcock Language Proficiency Battery- Revised raw scores

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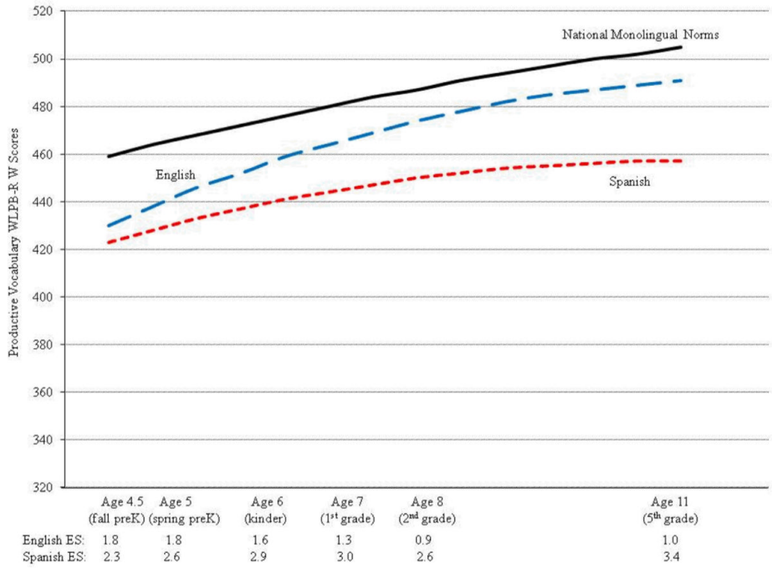

Figure 1.
Vocabulary growth trajectory from age 4.5 to 11 in English (long dashed line) and in Spanish (short dashed line), compared to national monolingual norms (solid line)

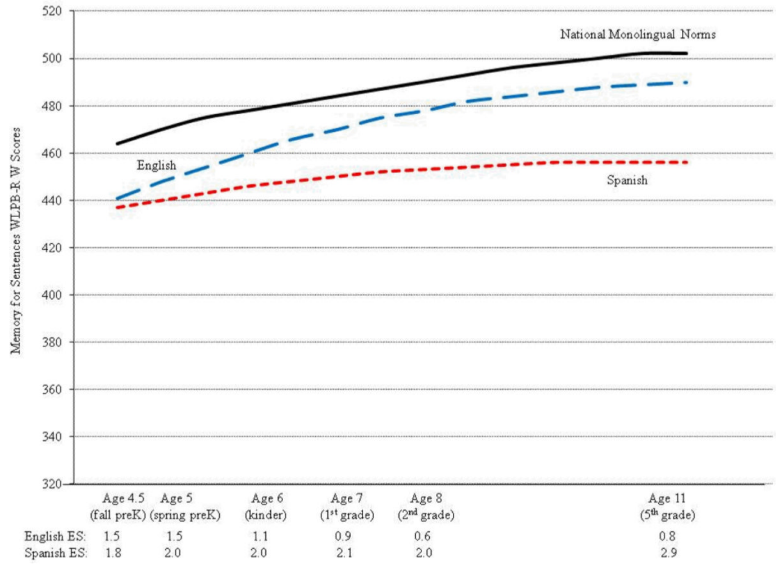

Figure 2.

Verbal short-term language memory growth trajectory from age 4.5 to 11 in English (long dashed line) and in Spanish (short dashed line), compared to national monolingual norms (solid line) (n = 173).

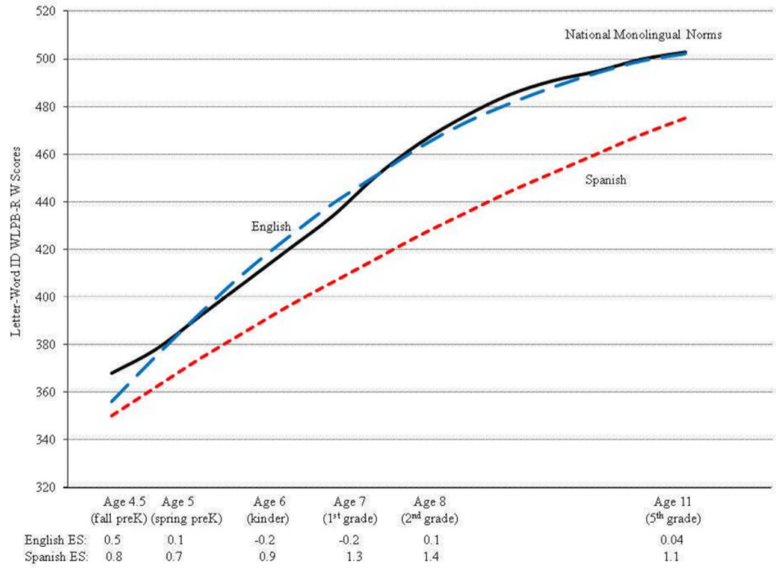

Figure 3.

Word reading growth trajectory from age 4.5 to 11 in English (long dashed line) and in Spanish (short dashed line), compared to national monolingual norms (solid line) (n = 173).

Table 1

Age of Testing (in months) at Each Measurement Point in English and in Spanish.

	N	English	N	Spanish
Time 1 (fall of preschool)	140	55.15 (4.17)	137	55.16 (4.17)
Time 2 (spring of preschool)	141	59.82 (4.12)	141	59.88 (4.13)
Time 3 (spring of kindergarten)	154	71.32 (3.99)	153	71.43 (4.09)
Time 4 (spring of 1st grade)	147	82.81 (4.23)	145	82.77 (4.25)
Time 5 (spring of 2nd grade)	144	95.67 (4.81)	138	95.67 (4.80)
Time 6 (spring of 5th grade)	173	132.47 (4.00)	173	132.47 (4.00)

Note. Four test dates were missing in the fall of preschool, twenty-five were missing in the spring of preschool, and only one was missing (in Spanish) in first grade. However, there were no significant differences between children missing test dates and those not missing them on word reading, vocabulary and verbal short-term memory (in English and in Spanish). Thus, the average test date was imputed.

Table 2

Sample Means on Vocabulary, Verbal short-term memory, and Word Reading by Wave, with Sample Standard Deviations in Parentheses

Measure	N	W Score	English SS	N	W Score	Spanish SS
Vocabulary						
Age 4.5	144	430.2 (19.5)	70.7 (19.0)	147	424.5 (16.3)	64.8 (17.0)
Age 5	166	436.5 (18.0)	71.7 (18.9)	166	427.1 (16.6)	61.2 (18.7)
Age 6	154	450.1 (16.1)	74.0 (20.0)	153	431.1 (18.5)	51.3 (22.5)
Age 7	147	462.3 (16.1)	79.1 (20.1)	146	438.3 (21.7)	49.9 (25.8)
Age 8	144	472.0 (15.7)	84.0 (18.8)	138	459.5 (29.9)	69.6 (34.7)
Age 11	173	490.9 (10.3)	85.5 (11.5)	173	455.4 (28.1)	48.7 (28.9)
Verbal Short-Term Memory						
Age 4.5	143	440.1 (21.4)	75.1 (20.4)	143	435.2 (16.5)	70.0 (16.7)
Age 5	166	447.9 (15.4)	78.5 (14.9)	165	441.5 (17.5)	72.1 (17.2)
Age 6	154	454.8 (16.0)	78.5 (15.3)	153	442.1 (21.5)	66.8 (18.1)
Age 7	147	469.0 (15.8)	87.1 (15.4)	146	451.1 (16.2)	70.2 (14.8)
Age 8	144	478.6 (16.1)	91.9 (15.4)	138	453.1 (19.5)	69.7 (16.0)
Age 11	173	489.3 (14.7)	88.7 (14.0)	173	455.9 (22.4)	58.9 (19.1)
Word Reading						
Age 4.5	144	356.5 (15.5)	90.9 (10.7)	146	353.8 (11.3)	89.2 (8.5)
Age 5	166	364.6 (18.4)	90.8 (12.6)	166	355.9 (12.1)	85.2 (9.6)
Age 6	154	399.8 (20.7)	96.3 (15.2)	153	375.6 (32.8)	80.1 (21.4)
Age 7	147	437.5 (26.2)	103.8 (17.8)	146	406.0 (49.9)	83.6 (31.4)
Age 8	144	467.6 (21.2)	105.6 (16.7)	138	431.1 (57.1)	86.4 (37.8)
Age 11	173	500.6 (18.2)	100.3 (14.2)	173	471.7 (42.9)	83.6 (28.6)

Note. $M = 100$, $SD = 15$ for the standard scores

Table 3

Results of Unconditional Growth Multilevel Models for Change for Vocabulary in English and in Spanish as a Function of Linear and Quadratic Age (n = 173).

			Model EV1 (unconditional means)	**English Model EV2**	**Model EV3**	**Model SV1 (unconditional means)**	**Spanish Model SV2**	**Model SV3**
Fixed Effects Initial Status, π_{0i}	Intercept	γ_{00}	457.6^{***} (1.0)	435.7^{***} (1.3)	430.4^{***} (1.4)	439.2^{***} (1.5)	426.9^{***} (1.2)	422.8^{***} (1.3)
Rate of change, π_{1i}	Linear Age (months)	γ_{10}		0.8^{***} (0.02)	1.3^{***} (0.04)		0.4^{***} (0.02)	0.9^{***} (0.1)
	Quadratic Age (months per month)	γ_{20}			-0.01^{***} (0.001)			-0.01^{***} (0.001)
Variance Components	Level 1: Within-person	σ^2_{ε}	638.2^{***} (32.7)	104.2^{***} (6.1)	75.5^{***} (4.4)	387.3^{***} (20.0)	197.8^{***} (11.6)	175.7^{***} (10.31)
	Level 2: Between person	σ^2_{0}	65.7^{**} (20.5)	256.3^{***} (32.2)	271.9^{***} (32.6)	296.1^{***} (40.0)	174.5^{***} (27.7)	184.9^{***} (27.8)
	In rate of change	σ^2_{1}		0.02^{***} (0.01)	0.02^{***} (0.01)		0.03^{***} (0.01)	0.03^{***} (0.01)
	Covariance	σ_{01}		-1.9^{***} (0.4)	-2.1^{***} (0.3)		2.2^{***} (0.4)	2.0^{***} (0.4)
Goodness of Fit Statistics	Deviance (−2LL)		8703.0	7373.3	7156.9	8399.3	7904.7	7835.3
	AIC		8709.0	7385.3	7170.9	8405.3	7916.7	7849.3
	BIC		8718.5	7404.2	7193.0	8414.8	7935.7	7871.4

* $p<.05$,

** $p<.01$,

*** $p<.001$

Table 4

Results of Unconditional Growth Multilevel Models for Change for Verbal Short-Term Memory in English and in Spanish as a Function of Linear and Quadratic Age (n = 173).

			Model EM1 (unconditional means)	English Model EM2	Model EM3	Model SM1 (unconditional means)	Spanish Model SM2	Model SM3
Fixed Effects Initial Status, π_{0i}	Intercept	γ_{00}	463.8*** (1.1)	446.1*** (1.2)	440.8*** (1.3)	446.6*** (1.2)	439.6*** (1.2)	436.9*** (1.3)
Rate of change, π_{1i}	Linear Age (months)	γ_{10}		0.6*** (0.02)	1.2*** (0.04)		0.2*** (0.02)	0.6*** (0.1)
	Quadratic Age (months per month)	γ_{20}			−0.01*** (0.001)			−0.004*** (0.001)
Variance Components	Level 1: Within-person	σ^2_{ε}	464.1*** (23.9)	115.7*** (6.8)	85.5*** (5.0)	206.9*** (10.7)	134.3*** (8.0)	126.2*** (7.5)
	Level 2: Between-person	σ^2_0	114.2** (22.1)	211.8*** (28.0)	215.3*** (27.0)	212.6***(27.2)	194.6**** (27.3)	193.2*** (26.9)
	In rate of change	σ^2_1		0.02* (0.01)	0.02*** (0.01)		0.02 (0.01)	0.02 (0.01)
	Covariance	σ_{01}		−1.0*** (0.3)	−1.2*** (0.3)		0.1 (0.3)	0.1 (0.3)
Goodness of Fit Statistics								
	Deviance (−2LL)		8467.3	7473.5	7273.7	7821.0	7578.0	7535.5
	AIC		8473.3	7485.5	7287.7	7827.0	7590.0	7549.5
	BIC		8482.8	7504.4	7309.8	7836.5	7608.9	7571.5

* p<.05,

** p<.01,

*** p<.001

Table 5

Results of Unconditional Growth Multilevel Models for Change for Word Reading in English and in Spanish as a Function of Linear and Quadratic Age (n = 173).

			Model EW1 (unconditional means)	English Model EW2	Model EW3	Model SW1 (unconditional means)	Spanish Model SW2	Model SW3
Fixed Effects Initial Status, π_{0i}	Intercept	γ_{00}	422.1^{***} (1.9)	368.7^{***} (1.25)	356.0^{***} (1.4)	399.6^{***} (2.2)	354.2^{***} (1.5)	350.2^{***} (1.8)
Rate of change, π_{1i}	Linear Age (months)	γ_{10}		1.9^{***} (0.03)	3.3^{***} (0.1)		1.6^{***} (0.1)	2.1^{***} (0.1)
	Quadratic Age (months per month)	γ_{20}			-0.02^{***} (0.001)			-0.01^{***} (0.001)
Variance Components	Level 1: Within-person	σ^2_{ε}	3254.3^{***} (151.1)	683.8^{***} (31.8)	539.0^{***} (25.0)	3075.6^{***} (157.4)	645.6^{***} (37.2)	614.1^{***} (35.6)
	Level 2: Between-person	σ^2_0				266.5^{**} (91.0)	147.6^{***} (42.6)	176.4^{***} (44.8)
	In rate of change	σ^2_1					0.2^{***} (0.04)	0.2^{***} (0.04)
	Covariance	σ_{01}					6.6^{***} (1.0)	6.0^{***} (1.0)
Goodness of Fit Statistics	Deviance (−2LL)		10139.0	8691.3	8470.4	10086.8	8920.7	8901.6
	AIC		10143.0	8697.3	8478.4	10092.8	8932.7	8915.6
	BIC		10152.6	8711.8	8497.8	10102.3	8951.6	8937.6

* $p<.05$,

** $p<.01$,

*** $p<.001$