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Investigating the Academic Vocabulary Development of Spanish-English Bilingual Students in Middle School

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This study examined the vocabulary development of Spanish-English bilingual adolescents (n= 98) from the end of 6th through the end of 7th grade in a dual language setting by looking at the patterns of growth in English and Spanish vocabulary post intervention and adding to the body of research on vocabulary development. Data were analyzed using descriptive statistics and Hierarchical Linear Modeling (HLM).

At the first level (TIME), the analysis helped to describe the shape of each person’s individual growth trajectory and to examine within person variability. The analysis at the second level (STUDENTS) considered inter-individual differences in order to detect heterogeneity in change across individuals and to determine the relationship between predictors and the shape of each person’s individual’s growth trajectory.

Evidence for study 1 ~ English Vocabulary Knowledge revealed that on average, students demonstrated significant growth in English vocabulary development. There was significant variation across students with regard to initial status but not with regard to rate of change. In addition, the conditional models suggested that ELL status and initial Spanish cognate knowledge were significantly associated with initial English vocabulary knowledge while English reading comprehension was not.

Evidence from study 2 ~ Spanish Cognate Knowledge revealed that on average,
students did not demonstrate significant growth in Spanish cognate knowledge. There was significant variation across students with regard to initial status but not with regard to rate of change. In addition, the conditional models suggested that while Spanish comprehension and initial English were significantly associated with initial Spanish cognate knowledge, the ELL status had no effect.

Findings from this study align with evidence from previous vocabulary studies showing similar results on the lack of accelerated growth. However, unlike other studies, this study provides reasons to be optimistic about cross-linguistic relationships for Spanish-English bilingual students. The results of this study have implications for designing instruction for Spanish-English bilingual students that is inclusive of more explicit and sustained instruction in both Spanish and English in the area of vocabulary.
Investigating the Academic Vocabulary Development of Spanish-English Bilingual

Students in Middle School

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B.S., Central Connecticut State University, 1996
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A Dissertation
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APPROVAL PAGE

Doctor of Philosophy Dissertation

Investigating the Academic Vocabulary Development of Spanish-English Bilingual Students in Middle School

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CHAPTER 1
INTRODUCTION

Problem Statement
Latinos\textsuperscript{1} are the fastest growing population in this country. Projections for the Latino population indicate that this group will more than double during the 2012-2060 period, from 53.3 million in 2012 to 128.8 million in 2060 (U.S. Census Bureau, 2010). In 2060, approximately one in three U.S. residents will be Latinos, up from about one in six in 2012 (U.S. Census Bureau, 2010).

The ongoing increase in the U.S. Latino population mirrors a parallel increase in the population of English language learners (ELLs), or students who speak a language other than English at home and have not achieved sufficient proficiency in English to participate in English mainstream instruction without support. Between 1998 and 2009, the school enrollment of ELLs in the U.S. grew by 51%, whereas the total school enrollment during the same time period was relatively flat at merely 7% (NCELA, 2011). This parallel increase in the population of ELLs and Latinos in the United States is not surprising, as the largest group of ELLs by far is Latinos, comprising 80% of the total ELL population (NEA, 2010).

At all academic grade levels, in all content areas, Latinos and ELLs are struggling to achieve academic success and be on par with their native-English-speaking classmates. These marked achievement gaps are evidenced through results of both national and state standardized assessments. At the national level, 2011 NAEP data indicates sizeable achievement gaps for both ELLs and Latinos at all grade levels in both reading and mathematics (National Center for Education Statistics, 2012). NAEP results for 8\textsuperscript{th} graders in 2011 show that 29% of ELLs scored

\textsuperscript{1} The term Latino will be used to refer to study findings that reference both Latinos and Hispanics.
at or above basic levels in reading compared with 77% of NON ELL’s. The pattern was the same for 4th graders, where 30% of ELLs scored at or above basic levels in reading compared with 70% of NON ELL students (National Center for Education Statistics, 2012). Likewise, larger percentages of Latino students scored below proficiency in reading at both grade levels, with 39% Latino 8th graders scoring below basic proficiency compared with 16% of White 8th graders, and 51% of Latino 4th graders scoring below basic as compared with 22% of White 4th graders (National Center for Education Statistics, 2012).

The 2011 NAEP scores in mathematics show similar trends. Among 8th graders, 72 % of ELLs scored below basic proficiency compared to only 25% of NON ELLs, and among 4th graders, 43% of ELLs scored below basic compared with 16% of NON ELLs. Likewise, among 8th graders, 39% of Latinos scored below basic proficiency compared to 16% of their White counterparts, and 28% of Latino 4th grade students scored below basic compared to 9% of White students National Center for Education Statistics, 2012).

Data on the performance of students in Connecticut indicate similar patterns at the state level. The results for the 2012 Connecticut Mastery Test (CMT) showed that 72% of ELL students in the 4th grade were below proficient in reading compared to 19% of NON ELLs. A subgroup comparison of Grade 8 ELL students and NON ELL students showed that the scores of 77% of ELL students were below proficient in reading as compared to 11% of NON ELLs. Likewise, larger percentages of Latino students scored below proficiency in reading at both grade levels, with 31% Latino 8th graders scoring below proficiency compared with 6% of White 8th graders, and 42% of Latino 4th graders scoring below proficiency as compared with 10.5% of White 4th graders (Data Interaction for CMT Test, 2012). These results exhibit the need to further
investigate this group of students. If current patterns continue, the economic and social consequences for Latinos in particular, and for our country as a whole, can be devastating.

Under the No Child Left Behind Act of 2001 (NCLB), states are required to ensure that all public school students meet standards of proficiency in math and reading by 2014, and levels of achievement must be measured separately for several categories of students, including those designated as ELLs. To meet that mandate, states, districts, and schools will presumably need to focus attention and resources on the student groups that are furthest from meeting standards. One problem with using the ELL classification to show group differences is that unlike race or gender classifications that are fixed, the ELL classification is constantly changing. Students designated as ELLs progress through higher levels of proficiency and are ultimately reclassified as fully English proficient, while new students with little to no English proficiency are constantly being added to the ELL subgroup. As a result, it is difficult if not impossible for the subgroup to show improvement over time, as the composition of the subgroup is constantly changing (Abedi, 2004). Recognizing this, there have been modifications that allow former ELLs to be included in this subgroup for up to 2 or 3 years after being reclassified. Modifications differ from state to state, but in Connecticut, former ELLs are now included in the ELL subgroup for AYP reporting for three years following reclassification to fully English proficient. However, it is still important to interpret ELL achievement gaps with some level of caution, as this is a constantly shifting group that by definition includes the students with the lowest levels of English proficiency.

One challenge in interpreting these results for Latinos and ELLs, respectively, is that they are partially overlapping subgroups, each with substantial diversity with regard to race, native language, national origin, and socioeconomic status. Not all ELLs are Latino, and not all Latinos are ELLs. Among the Latino population in the United States, language proficiency ranges from
monolingualism in Spanish to full bilingualism in English and Spanish, to full monolingualism in English, with all levels of shading in between. Some Latino students are currently ELLs, others are former ELLs who have been reclassified as fully English proficient, others are fluent in Spanish but have also always had sufficient proficiency in English to avoid ever being classified as ELL, and still others have limited or no exposure to Spanish whatsoever. Research into the achievement gap for Latino students in the U.S. must take this linguistic diversity into account.

One key area of academic performance is reading comprehension, as it is both important in its own right and a gateway to learning in all content areas. In addition to the large-scale NAEP studies, other research has confirmed the challenges that ELLs and Latinos face in acquiring English reading ability. The report of the National Literacy Panel on Language Minority Children and Youth (August & Shanahan, 2006), found that students learning English did not perform as well on measures of reading comprehension as their native English-speaking peers, and that oral language proficiency in English and English reading comprehension are positively correlated, meaning that students with lower levels of oral English proficiency are likely to have more difficulty with English reading tasks.

A national commission on reading achievement found vocabulary to be one of the five core areas of reading development (National Reading Panel, 2000) and this was echoed by the National Literacy Panel on ELLs (August and Shanahan, 2006). The importance of vocabulary knowledge becomes particularly noticeable in the late elementary grades, when a large shift happens in reading. Chall (1987) put forth the idea that as students advance from the early stages of learning to read (decoding) in primary grades to more complex, comprehension-based reading in the intermediate grades, they encounter more complex and unfamiliar content area vocabulary. Reading assessment scores drop for certain students, especially those from low SES backgrounds.
Because they often come from low SES backgrounds, Cummins (2003) contends that this drop in scores affects a disproportionate number of ELLs. Research on ELLs has born this out, showing that many students who were meeting grade level benchmarks in terms of decoding showed a decrease in reading comprehension in the intermediate grades, in part due to low vocabulary (August & Shanahan, 2006).

**Purpose of the Study**

Vocabulary development is critically important for the improvement of overall literacy for both native English speakers and ELLs. It has been shown that as in many other domains of literacy, ELLs lag behind their English speaking peers in depth and breadth of vocabulary knowledge; however, there has been very little research investigating the development of vocabulary among ELLs in general or Spanish-English bilinguals in particular, especially in the middle school grades (August & Shanahan, 2006). This restricted focus in current research limits our understanding of how we can better serve this student population; therefore, the purpose of this dissertation is to investigate the English and Spanish academic vocabulary development from the beginning of 6th grade to the end of 7th grade among Spanish-English bilingual adolescents enrolled in a dual language school that participated in a vocabulary intervention project that targeted Spanish-speaking middle school students. The students received the intervention in 6th grade, prior to the start of data collection for this study. The intervention will be described in more detail in Chapter 3.

**Theoretical Rationale**
My theoretical framework of how Spanish-English bilingual students learn is situated around the idea of cross-linguistic transfer (Odlin, 1989). The term *transfer* refers to the influence resulting from similarities and differences between native language and a second language (Odlin, 1989). Transfer generally suggests that well-developed L1 literacy skills will likely result in a faster acquisition of related skills in the L2 (Cummins, 1979, 1984).

Transfer is influenced by cognitive abilities, contextual learning, and linguistic factors (Jarvis & Pavlenko, 2010). Cognitive abilities are mental skills that help an individual produce and understand language. For example, memorizing, reasoning, problem solving and decision making are all mental processes that require cognitive abilities. Contextual learning refers to real experiences within specific contexts that help an individual develop his or her cognitive abilities. For example, the type of learning that takes place when teachers present information in such a way that students are able to construct meaning from within their own experiences. This type of learning emphasizes problem solving and emphasizes that teaching and learning need to occur in multiple contexts. Lastly, linguistic factors refers to language and imply that language learning can occur in instructed or natural settings. Examples of linguistic factors are; language structure or grammar; sound systems or phonology; the formation and composition of words or morphology and the formation and composition of phrases and sentences from words or syntax (Jarvis & Pavlenko, 2010; Odlin, 1989). Cognitive, contextual and linguistic factors are influential and intertwined within the idea of cross-linguistic transfer therefore leading to different theories of language acquisition and transfer.

One theory most commonly associated with second language learning is the Linguistic Interdependence Hypothesis (LIH). This theory posits that if the outside environment provides sufficient stimulus for maintenance of L1, then intensive exposure to L2 in school leads to rapid
bilingual development with no detrimental effects in L1 (Cummins, 1979, 1984). Moreover, the hypothesis states that strong L1 language skills transfer to L2 language skills although students sometimes may not realize that what they know in their first language (L1) can be applied to their second language (L2).

There are clear differences in acquisition and developmental patterns between conversational language known as BICS (basic interpersonal communicative skills) and academic language known as CALP (cognitive academic language proficiency). The conceptual distinction between BICS and CALP highlights misconceptions about the nature of language proficiencies. All children acquire their conceptual foundation also known as knowledge of the world, through conversational interactions, BICS. Literacy and vocabulary knowledge fall under CALP and it is believed that they develop at least throughout schooling and throughout our lifetimes (Cummins, 2000). The implicit assumption that BICS in English is a good indicator of English proficiency is a misconception that has allowed many educators to misunderstand the idea of transfer and assume that transfer is automatic when in reality, explicit instruction must take place in order to ensure that transfer occurs.

For this dissertation, my theoretical framework is situated primarily in Cummins’ Linguistic Interdependence Hypothesis (LIH) (Cummins, 1979). This hypothesis has given rise to the idea of transfer. Moreover, it predicts that reading instruction and strategies developed in one language can lead to literacy skills in that language as well as linguistic proficiency in other languages.

Empirical research investigating the linguistic interdependence hypothesis and the idea of transfer have revealed complexities in trying to prove that transfer occurs. Cross-linguistic relationships in oral language and literacy have been found to exist in a variety of domains, and it is believed that these relationships support the idea of transfer, but it is a difficult concept to
prove definitively (Dressler and Kamil, 2006).

Moreover, there are complexities inherent in the notion of transfer, such as the direction in which transfer occurs. Transfer may occur from the L1 to the L2 and/or from the L2 to the L1, a concept known as reverse transfer or bidirectional transfer (Howard, Green, & Arteagoitia 2012; Pavlenko & Jarvis 2002). Another complexity involves the different language and literacy domains in which transfer occurs; transfer may occur in some constructs such as alphabetic and word-knowledge more easily than in more complex constructs such as oral language, vocabulary and comprehension (Odlin, 1989; Proctor, August, Snow, & Barr, 2010). Lastly, a major complexity is the type of educational model used to promote second language development. The additive bilingual education model refers to an educational context that promotes the continual development of the native language and maintenance of the home culture while adding a second language and culture. This type of model embraces the linguistic and cultural differences; therefore, allowing the students to feel comfortable with the usage of two or more languages. In contrast, the subtractive bilingual educational model replaces the home language and culture with the English language and the mainstream U.S. culture (Cummins, 2000). This model can be problematic as it does not embrace the linguistic and cultural differences and therefore seeks assimilation. These complexities have all been revealed as research continues to find ways to clarify and validate the idea of how/if or when transfer occurs.

My research was situated in a dual language school where bilingualism is promoted in an additive bilingual education model. Students’ primary language is developed and maintained as a second language is added. This particular school setting reaps the potential benefits of interdependence since instruction focuses on language and literacy development in both languages. In addition, the cognate-based intervention that the students received was key to
promoting vocabulary transfer and cross-linguistic effects of Spanish-English bilinguals since instruction in both languages was present. Since the acquisition of vocabulary can be difficult for students, it may also be harder to transfer across languages, and cognates are a promising avenue to further investigate the notion. Because the research was situated in a dual language setting, this theoretical framework served me well as I sought to investigate the vocabulary development of Spanish-English bilinguals.

**Research Questions**

In an effort to examine the English vocabulary development of Spanish-English bilingual adolescents who received a cognate-based vocabulary intervention during their 6th grade year and were enrolled in a dual language school from at least the beginning of 6th grade to the end of 7th grade, I posed these four questions:

1a. What are the initial status and the rate of change of English academic vocabulary development among Spanish-English bilingual students from the end of 6th grade to the end of 7th grade?

1b. Controlling for English reading comprehension ability, do initial status and/or rate of change of English academic vocabulary development vary according to ELL status and Spanish cognate knowledge?

2a. What are the initial status and the rate of change of Spanish cognate vocabulary among Spanish-English bilingual students from the end of 6th grade to the end of 7th grade?

2b. Controlling for Spanish reading comprehension ability, do initial status and/or rate of change of Spanish cognate vocabulary vary according to ELL status and English vocabulary knowledge?
Overview of Dissertation

This dissertation is divided into five chapters. In Chapter 1, I have discussed the struggles faced by Latinos and ELLs in realizing academic success, as well as the importance of vocabulary in supporting students’ reading comprehension and overall academic success. In Chapter 2 of this dissertation, within the theoretical framework of cross-linguistic transfer, I provide the research base on the development of reading and academic vocabulary among Spanish-English bilinguals, and the extent to which positive relationships have been noted across English and Spanish abilities in these areas. In Chapter 3, I describe the methodology used in this study, including information on the setting, participants, research design, instrumentation, and data collection procedures of this study. In Chapter 4, I present the approach to data analysis and findings of this study. Finally, in Chapter 5, I discuss the results of the findings, highlight implications, note limitations, and suggest recommendations for future research.
CHAPTER 2
LITERATURE REVIEW

Introduction

In Chapter 1, the rationale for this study was presented: Latinos in general are the fastest growing population in this country, and Spanish speakers make up the largest and fastest growing population of second language learners in the United States and sizeable achievement gaps are well-documented for both groups. Increasing the academic vocabularies of Spanish-English bilingual adolescents is crucial for ensuring both their literacy attainment and overall academic success. As such, it is important to investigate the academic vocabulary development of Spanish-English bilingual middle school students. Following a brief description of the Latinos population in the United States and the difficulties in academic achievement that they frequently face, this literature review will convey findings that address these three inter-related issues for Spanish-English bilingual adolescents:

- reading comprehension
- academic vocabulary development
- cognate knowledge

Latinos in U.S. Schools

There are 50.5 million Latinos currently living in the United States (Pew Hispanic Data Center, 2012). Many of the U.S. public schools have large number of Latino youth. For example, the 2010 Census reported that among all pre-K through 12th grade public school students, 23.9% were Latinos. In particular, in the state of Connecticut, there are currently 482,000 Latinos, approximately 115,000 of which are K=12 students (Pew Hispanic Data Center, 2012). As the
number of Latino students continues to increase, many public school systems are struggling with the challenges of serving these linguistically and culturally diverse students.

The educational experiences of many Latino youth in the U.S. have often been negative (Irizarry, 2011). Many have been denied opportunities to connect with their cultural backgrounds and to communicate in their dominant language of Spanish. Recently, Arizona’s legislature has gone so far as to ban the teaching of ethnic studies in K-12 schools, and several years ago they likewise eliminated native language instruction for ELLs. The broader political climate has also made it difficult for Latino students to find a sense of belonging in U.S. Schools (Irizarry, 2011; Nieto, 2000).

A great majority of Latino immigrants settle and carry out productive lives in the United States and eventually produce new generations of U.S. born Latinos who develop or maintain different kinds of connections to their parents’ native lands. There are those who continue with the migration patterns with a great deal of back-and-forth movement. The Puerto Ricans in particular are representative of this group (Nieto, 2000; Rivera-Batiz & Santiago, 1994).

Currently there are 4.6 million Puerto Ricans who live in the United States (Pew Hispanic Data Center, 2011). According to the 2010 census, this represents over 9.2% of the total Latino population in the U.S. Puerto Rican migration to the United States grew out of specific political and socioeconomic conditions under Spanish colonial rule and later as a member of the U.S. Commonwealth, (Acosta-Belen & Santiago, 2006; Nieto, 2000). The current association between the United States and Puerto Rico is the result of a set of economic and political factors that developed throughout the nineteenth century, intensified during the twentieth, and still shapes lives and conditions faced by Puerto Ricans in both Puerto Rico and the United States (Acosta-Belen & Santiago, 2006). This unique colonial bond shapes the relationship between Puerto Rico and the U.S. These policies and actions have led to an overwhelming influx of Puerto Ricans to
The United States, primarily to the Northeastern states, including Connecticut.

The traditional immigrant patterns of bilingualism in the United States has often followed trajectories of erosion where native language is lost and the English language is acquired and maintained (Hakuta, 1986). For Puerto Ricans and many other Latinos in the United States, English and Spanish language use has been a marker of cultural, social, and political identities therefore not following that pattern of erosion (Nieto, 2000). Even when young people are not born in Puerto Rico and have little direct connection with the island and culture, they seek to retain their Puerto Rican heritage as a symbol of their identity (Rodriguez, 1991). Bilingualism has often become necessary for Puerto Ricans in particular, because of circular migration patterns that are constant with the back and forth movement to and from Puerto Rico. Furthermore, if one is to function in familial networks, and communities, one must maintain a level of bilingualism. In many U.S. Schools, we often find many Latino students seeking to maintain bilingualism therefore; their home language is usually Spanish. Due to the primary language used at home, many of these students are considered to be ELLs even if they are born in the United States. Since Latinos are the fastest growing minority group in the United States and there are notable achievement gaps that have been documented, particularly for those that are also ELLs, the next section of this literature review seeks to explore reading, as it is one key area of academic attainment.

Reading Comprehension

Reading is the cornerstone of all school-based learning. Across all content areas, reading is a requirement in order to learn. At a basic level, children who are acquiring reading skills must establish a system of correspondences between letters of printed words and phonemes of spoken words (Ehri, 1992). Perhaps children who learn these basic skills well, will carry them on
throughout their schooling and be successful readers and learners. For students who do not attain reading achievement, many challenges may be presented because it is believed that students who show inconsistencies in reading achievement are likely to develop inconsistencies in all areas of the curriculum (August & Shannahan, 2008; Echevarria, Vogt, & Short, 2004; Genesee et al., 2006). It is challenging for many ELL students to attain reading achievement levels that are high enough for them to thrive in different content areas and comprehension is a big part of this struggle. Children need to comprehend what they read.

Early adolescence is a critical time in the development of reading comprehension, because it is the time when students stop learning to read and begin reading to learn (Chall, 1987). The increase of language difficulty in texts from different content areas at this age level is also a factor to consider. Texts become increasingly complex as students enter the upper elementary and middle-school grades (Fitzgerald, 1995). The vast majority of middle school students with reading difficulties struggle with understanding word meaning and the comprehension of text. The development of the lower level skills is a strong focus of early elementary education but by fifth grade, the language demands of grade level texts have increased and strong word meaning must be accompanied by comprehension skills (Proctor, August, Carlo & Barr, 2010). For ELLs, this combination of word meaning and comprehension can be difficult as they may often be developing skills in their native language while transitioning to English instruction.

Many students struggle with comprehension sub skills such as recognizing information from text and finding main ideas, and without interventions limited literacy skills can have long-term consequences including high school dropouts (Faggella-Luby, Ware & Capozzoli, 2009). When it comes to the ELL student population, the issue is even more concerning. ELLs graduate from high school at far lower rates than do their native English speaking peers; about 31% of ELLs fail to complete high school (Short & Fitzsimmons, 2007).
Instruction that provides relevant literacy skills in specific content areas can enhance the development of reading comprehension for adolescents during this critical time. Specifically, ELLs may benefit from instruction that activates prior knowledge and skills in order to build background knowledge related to content area topics previously encountered but not mastered (Faggella-Luby, Ware & Capozzoli, 2009). Vocabulary instruction is often recommended as one method of advancing comprehension across all grades and languages. “Vocabulary development is both an outcome of comprehension and a precursor to it with word meanings making up as much as 70-80 percent of comprehension” (Bromley, 2007, p.528). Because of the critical importance of vocabulary development as a component of reading comprehension and overall academic achievement, the next section provides a summary of the research on the vocabulary development of ELLs, particularly Spanish-English bilinguals, and the associations that have been found between vocabulary knowledge and reading comprehension for this population.

The Importance of Vocabulary Development for Reading Comprehension

Teachers and researchers have long recognized the important and prominent role that vocabulary knowledge plays in becoming a successful reader. According to Stahl and Fairbanks (1986), vocabulary knowledge has been identified as the most important indicator of oral language proficiency, which is particularly important for comprehension of both spoken and written language (Proctor, Carlo, August, & Snow, 2005). Some research has also indicated that the failure to recognize even 2% of the words in a specific text will limit comprehension (Hirsh & Nation, 1992 as cited in Proctor et al., 2005), making general academic vocabulary the single best predictor of reading comprehension (Anderson & Freebody, 1981).

Limited vocabulary is one major determinant of poor reading comprehension for ELLs in particular (August & Shanahan, 2006; Becker, 1997; García, 1991; Nagy, 1997). In fact, in
examining the five areas of reading promoted by the National Reading Panel (2000) (i.e. phonemic awareness, phonics, fluency, vocabulary, and comprehension), researchers determined that ELLs tend to struggle the most with vocabulary and comprehension at all grades (Goldenberg & Coleman, 2010), and this can result in difficulties mastering academic content.

Moreover, ELLs not only tend to have smaller English vocabularies than their native English-speaking peers, but they also lack depth of vocabulary knowledge (Carlo et al., 2004). Traditionally, research on vocabulary knowledge has been concerned with the breadth of vocabulary knowledge; for example, with the number of words in the child’s lexicon (how many words a student knows). Vocabulary depth is just as important to look at since it involves how well the students knows the meaning words and all word characteristics such as phonemic, morphemic and syntactic properties (Ordonez, Carlo, Snow, & McLaughlin, 2002 & Nagy, 1997). Not only do ELLs know fewer words than EO students but they know less about the meaning of these words. Vocabulary depth has been shown to be as important as vocabulary breadth in predicting the performance in ELLs on reading comprehension (August, Carlo, Dressler, & Snow, 2005).

Relative to their native English-speaking peers, the limited breadth and depth of English vocabulary that many ELLs possess creates a real challenge for reading. Students reading in their first language have already learned approximately 5,000 to 7,000 words before they begin formal reading instruction in schools (Biemiller & Slonim, 2001). However, second-language learners typically have not already learned a large store of oral language vocabulary in the second language (Grabe, 1991). Reading itself is frequently cited as an effective approach for furthering vocabulary development (Anderson & Freebody, 1981); but this is often problematic for ELLs, who may face limited opportunities for extended reading in their second language (Grabe, 1991), and/or who may be slower and less automatic in recognizing words in English than first language
readers are (Favreau & Segalowitz, 1983). With ELLs in particular, reading alone does not appear to be a sufficient method for increasing vocabulary, and a few studies have looked at the effects of instructional interventions to promote the vocabulary attainment of this population.

One study of vocabulary knowledge and reading comprehension in ELL 4th and 5th grade students indicated that gains can be made by non-native speakers in vocabulary development and reading comprehension over time if they receive an enriched program of vocabulary instruction (McLaughlin, August & Snow 2000). This study involved an even number of native English speakers and Spanish-speaking ELLs in twenty-four 4th and 5th grade classes across three schools. Half of the students received an intervention that focused on direct instruction of target words along with word-learning strategies such as contexting, structural analysis, and cognate awareness. The intervention group performed better on a cloze reading comprehension assessment than the control group, with greater benefits for the native Spanish speakers.

A related study states that vocabulary knowledge serves a “predictive role in the reading comprehension process among ELLs” (Proctor, Carlo, August, & Snow, 2005, p. 254). The participants in this study were 135 Spanish-English bilingual Spanish speaking students from the 4th grade. This study took into account the students Spanish language skills because Spanish was their native language. It compared them to their English comprehension skills because English was their language of instruction. The results indicated an important connection between the Spanish vocabulary knowledge and English reading comprehension of the students. Results revealed a significant main effect for Spanish vocabulary knowledge and an interaction between Spanish vocabulary and English fluency. It also shows that English and Spanish fluency levels correlated significantly showing evidence of positive transfer among decoding and word reading skills between the two languages.

Another related longitudinal study (Nakamoto, Lindsey & Manis, 2008), investigated the
associations of third grade language and sixth grade reading comprehension with 282 Spanish-English Bilinguals and found that English reading comprehension was improved via the interaction of English decoding and Spanish vocabulary breadth.

Finally, Tran (2006) conducted a study and concluded that teachers can best support ELL students in building a basic vocabulary through a combination of modified extensive reading and explicit vocabulary instruction. Specifically, instructional approaches that integrate reading and explicit vocabulary instruction seems optimal in order to help all students obtain higher vocabulary achievement, which in turn leads to higher comprehension and overall academic achievement.

A recent longitudinal study (Mancilla-Martinez & Lesaux, 2010), provides insight into English reading comprehension for 173 ELLs from Spanish speaking homes. This study assessed whether performance in measures of word reading and vocabulary administered annually in both Spanish and English beginning at age 4.5, predicted English reading outcomes at age 11. Spanish vocabulary and word reading were not significant predictors of English reading comprehension.

Another study by Proctor et al., (2012) investigating the role of vocabulary development on English reading comprehension among 294 monolingual and Spanish-English bilingual children in grades two through four revealed that Spanish language proficiency was not associated with English reading comprehension, in line with the findings from Mancilla-Martinez and Lesaux (2010) mentioned above. In both of these studies, none of the bilingual students received any form of Spanish language instruction; in contrast, the students from both Nakamoto et al., (2008) and Proctor et al., (2005) received some instruction in Spanish therefore indicating that perhaps some instruction in the students’ native language may be helpful. The findings suggest that explicit vocabulary support is essential for ELLs because low vocabulary
levels limit their ability to make meaning from the text they read and in turn, limit their ability to gain vocabulary and word knowledge through reading, thereby limiting comprehension.

Summarizing, vocabulary knowledge is a crucial component for improving English reading comprehension outcomes for Spanish-speaking ELLs. The results of research are indicative of the critical nature of vocabulary in relationship to reading comprehension for Spanish-speaking ELLs.

Research has allowed us to conclude that vocabulary knowledge is crucial to reading comprehension and to success in school for both native English speakers and ELLs (National Reading Panel, 2000 & August & Shanahan, 2008). Finding effective and efficient ways to bolster students’ vocabularies is essential. Generally, the findings of studies conducted with ELLs provide evidence for the positive effects of first language (L1) knowledge on second language (L2) vocabulary and comprehension development; but they indicate that a strong foundation in the L1 and/or explicit instruction that facilitates connections across languages is necessary for this transfer to occur. One strategy to date that has been found to be especially valuable for Spanish-speaking students is their knowledge of cognate words. Cognates are words in two or more languages that share a common root and are therefore similar in meaning, spelling, and/or pronunciation (Lubliner & Heibert, 2008). The next section focuses on cognate awareness and instruction as a sub-component of vocabulary learning in particular for Spanish-English bilinguals because the explicit instruction of cognates can be a promising avenue for the development of academic vocabulary ability in ELLs.
The Role of Cognate Knowledge in the Vocabulary Development of Spanish-English Bilinguals

Since the majority of academic vocabulary terms in English have Latin or Greek roots, Spanish-English bilingual students may have an advantage over English-only students because these words often have close Spanish cognates, many of which are common, high frequency words in Spanish (Lubliner & Heibert, 2008). Research that has investigated cognate relationships between vocabularies in the L1 and L2 provides evidence of how Spanish-English bilinguals can draw on knowledge that is specific to the L1 when developing vocabulary in the L2. Various studies (Hancin-Bhatt & Nagy, 1994; Jimenez, García and Pearson, 1996; Nagy, García, Durgunoglu, & Hancin-Bhatt, 1993) provide evidence for cross-language transfer of cognate vocabulary. Results also highlight that positive transfer of vocabulary knowledge is most likely to occur when it involves languages that are typologically similar such as Spanish and English.

There are also many important student-level factors that determine the ease of vocabulary transfer across languages. One important criterion for the occurrence of transfer is the metalinguistic awareness of cognate relationship on the part of the learners. This awareness appears to be developmentally mediated, with older students showing greater metalinguistic awareness than younger ones (Hancin-Bhatt & Nagy, 1994; Nagy et al., 1993). Another factor is the level of L2 reading ability. More specifically, (Nagy et al. 1993 & Jimenez, García and Pearson, 1996), found that more successful L2 readers were better able than less successful L2 readers to explicitly recognize Spanish-English cognates during reading. These researchers also found that the ability to translate cognates from L2 to L1 was linked to students’ level of bilingualism and their knowledge in L1 vocabulary. This is particularly important when investigating Spanish-English bilinguals. Lastly, the level of L1 vocabulary may be a point of
departure since cognates may have an impact in the students’ ability to transfer across languages. The frequency of cognates in academic English is evident. We also know that all second language learners know something about language from knowing their first language. If we explicitly teach the students cognate recognition and we allow them to use their metalinguistic and metacognitive skills, we can help them as they make connections and possibly transfer skills from their L1 to the L2.

Cognate awareness can lead to an increase in general vocabulary knowledge for Spanish-English bilinguals. A study of cross language effects on vocabulary development was identified (Carlisle, Beeman, Davis, & Spharim, 1999). The purpose of this study was to determine how Hispanic students’ native language and second language proficiencies were related to their metalinguistic development and achievement in English. The participants for this study were students in grades 1, 2 and 3 who came primarily from homes where Spanish was spoken. The results of this study indicated that there was a strong relationship between vocabulary knowledge and the ability to give definitions in that language. The results also suggested a cross-language transfer of formal definitional structure, meaning that the children probably learned the form of definitions in English because this was the language of instruction, but they showed an ability to use the definitional form in Spanish (their native language). This sort of transfer could not have occurred had the children not been actively learning English. Teaching cognates can aid in the development of cross-linguistic effects and also help students to maintain their native language. Cognate study can be employed to teach students how to analyze the English language and make sense of unknown vocabulary words in that language by taking advantage of the students’ knowledge and literacy in their first language. Teaching children to notice and utilize linguistic resources such as these can aid in the development of vocabulary and reading comprehension.
Cognate knowledge also relates to improved reading comprehension for Spanish speakers. A qualitative study (Jimenez, García, & Pearson, 1996) examined the influence of Spanish speaking ELLs’ understanding of cognate relationships on their reading comprehension. Jimenez et al. (1996) reported that bilingual students in Grades 6 and 7 who had a better awareness of the relationships between English and Spanish cognates used more successful strategies to infer word meaning, which in turn enabled them to comprehend texts better. A study mentioned earlier (Nagy et al. 1993) also found that students’ performance on an English reading comprehension assessment containing cognates was mediated by their first language vocabulary knowledge and their ability to recognize cognates. These studies illustrate that language background and cognate knowledge seem to influence reading performance, and point to the value of explicit cognate instruction as a promising avenue for the development of academic vocabulary and reading comprehension in ELLs.

Conclusion

In summary, vocabulary development is critically important for the improvement of overall literacy for both native English speakers and ELLs. It has been shown that as in many other domains of literacy, ELLs lag behind their English speaking peers in depth and breadth of vocabulary knowledge. Although in recent years research has begun to investigate the development of vocabulary among ELLs in general and Spanish-English bilinguals in particular, it is important to continue to further investigate developmental and instructional approaches educators can take to better understand and better serve this student population. This study seeks to build on the research reviewed in this chapter by investigating cross-linguistic effects on English and Spanish vocabulary development among Spanish-English bilinguals who are enrolled in a dual language program and who participated in a cognate-based vocabulary intervention. Chapter 3 provides details about the methodology for the study.
CHAPTER 3

METHODOLOGY

Introduction

This study was embedded within a federally funded intervention project entitled *Content-Based Vocabulary Instruction: Using Cognates to Promote the Vocabulary Development and Reading Comprehension of Native Spanish Speakers* ([http://www.cal.org/projects/cognates.html](http://www.cal.org/projects/cognates.html)) that involved over 600 students in three middle schools and one preK-8 dual language program. The goal of that project was to develop and evaluate the effect of a cognate-based intervention on the development of English language (i.e., vocabulary, morphology, spelling, and reading comprehension) among native Spanish speakers in middle school grades. This dissertation study sought to extend the larger study by using a developmental approach to investigate patterns of academic vocabulary growth among Spanish-English bilingual students in middle school.
Specifically the study followed 98 students from the end of 6th through the end of 7th grade. The first data point was collected in May of the students’ 6th grade year. The other three data points were collected in September, January and May of the students’ 7th grade year. This study investigated the following research questions:

1a. What are the initial status and the rate of change of English academic vocabulary development among Spanish-English bilingual students from the end of 6th grade to the end of 7th grade?

1b. Controlling for English reading comprehension ability, do initial status and/or rate of change of English academic vocabulary development vary according to ELL status and Spanish cognate knowledge?

2a. What are the initial status and the rate of change of Spanish cognate vocabulary among Spanish-English bilingual students from the end of 6th grade to the end of 7th grade?

2b. Controlling for Spanish reading comprehension ability, do initial status and/or rate of change of Spanish cognate vocabulary vary according to ELL status and English vocabulary knowledge?

Setting and Recruitment

The study took place in New Beginnings School², a preK-8 whole-school dual language program in the northeast United States. New Beginnings is located in a city considered to be urban core. Urban Core cities are characterized as having the (1) lowest income, (2) highest poverty, and the (3) highest population density, with an extremely high population density being the primary characteristic for this category (Connecticut State Data Center, 2007).

² All of the names of places and individuals have been changed to pseudonyms for the purpose of this study.
According to the 2009-2010 *Strategic School Profile*, the student enrollment at New Beginnings School comprised 794 students in grades K-8. Consistent with the city’s urban core designation, the majority of students (81.5%) were eligible for free/reduced lunch. More than three-quarters of the student population (77.5%) came from homes where English was not the primary language, with almost half of all students (45.4%) not fluent in English and therefore eligible for ESL services. The total minority student population was reported to be 87.8%. The race/ethnicity was identified as 76.6% Hispanic, followed by 12.2% White, 10.6% Black and .9% Asian American.

The *Strategic School Profile* also reported the student performance on the Connecticut Mastery Test. When the students in this sample were in 5th grade, only 21.4% met state goal in reading in comparison to 25.6% district-wide and 61.8% statewide. Similar patterns were visible in writing. Only 27% of the students met state goal in writing in comparison to 31.6% district-wide and 68.2% statewide.

Because of the low literacy performance of students in the school and in the district, the principal and teachers were highly motivated to participate in a vocabulary intervention study designed specifically for Spanish-English bilingual students. The principal investigator of the larger study had a pre-established relationship with the principal of New Beginnings, and recruited the school through an initial email contact followed by a formal presentation to the principal and members of the district’s central administration. Once school and district approval was secured, the principal spoke with the nine teachers at the middle school level, and four of them (2 - 6th grade teachers – and 2 - 7th/8th grade teachers) volunteered to participate.

**Dual Language Education**
At the time of the study, New Beginnings School followed a dual language model. Dual language programs, sometimes called two-way immersion programs, are part of a growing trend in bilingual education that seeks to provide high quality content and language education for both language minority and language majority students (Howard & Sugarman, 2007). Dual language is a form of education in which students are taught literacy and content in two languages (Torres-Guzman, 2002). The purpose of dual language education is to aim for bilingualism, biliteracy, and cross-cultural competence in addition to academic achievement equal to that of students in non-dual language programs. Dual language programs are considered to promote bilingualism in a way that students’ primary language is developed and maintained as a second language is added. Two languages are used for instruction, learning, and communication within the dual language model. The dual language model is considered to be an additive bilingual instruction model that allows students to develop strong skills in both their native language (L1) and the second language (L2) without sacrificing mastery of the core academic content (Howard, 2002). In this way, dual language programs are different from transitional bilingual programs, where the aim is to transition students out of their native language and into English as quickly as possible.

At New Beginnings School, from Pre-K-5th grade, students had two primary teachers, with one providing instruction in English and the other providing instruction in Spanish. The students switched teachers and classrooms on a weekly basis, and received ongoing instruction in each language. When the students reached 6th grade, the schedules changed. Starting in grade 6, the students had language arts every single day but the language of instruction switched on a daily basis. For example, on A-day, students received language arts instruction in Spanish, while

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3 The term “Dual Language” is often used interchangeably with two-way immersion. Other variations of “Dual Language” are dual immersion and dual enrollment.
4 Bilingualism refers to the ability to speak fluently in two languages.
5 Biliteracy refers to the ability to read/write fluently in two languages.
on B-day, students received language arts instruction in English. The language of instruction for subjects like math and science alternated every other day. For example, A day was science in Spanish, B day was Math in Spanish, then A day was science in English and B day was math in English. The instructional blocks were typical of a block-scheduling approach, with 120 minutes of instructional time being the norm for a given block. The table below provides a summary of the typical schedule for the 6th grade students during the 2010-2011 school year. The schedule for the 2011-2012 school year, while the students were 7th graders, was similar. Due to the nature of the dual language program, the development of vocabulary growth observed took place over time in an environment where the socio cultural component of bilingualism was evident throughout the school.

Table 1

Typical Schedule Summary Chart - 2010-2011 School Year

<table>
<thead>
<tr>
<th>Subject</th>
<th>Monday A day</th>
<th>Tuesday B day</th>
<th>Wednesday A day</th>
<th>Thursday B day</th>
<th>Friday A day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Arts</td>
<td>Spanish</td>
<td>English</td>
<td>Spanish</td>
<td>English</td>
<td>Spanish</td>
</tr>
<tr>
<td>Math</td>
<td>Spanish</td>
<td></td>
<td>English</td>
<td></td>
<td>Spanish</td>
</tr>
<tr>
<td>Science</td>
<td></td>
<td>Spanish</td>
<td></td>
<td>English</td>
<td></td>
</tr>
</tbody>
</table>

Description of Intervention
All of the students in all four participating 6th grade classrooms received a cognate-based vocabulary intervention called *Words in Motion* (Howard, Dressler & Martínez-Alvarez, in press), developed as part of the federally funded grant referenced earlier (EVoCA). The *Words in Motion* curriculum was developed using a research-based approach that built on existing practices that have been shown to be effective for Spanish speaking students (Howard & González, in press). It focused on teaching general academic vocabulary in English and Spanish and the fact that all words were cognates was made very explicit. The cognate words and other connections were continuously made across English and Spanish with regard to target words and their constituent parts (i.e. roots and affixes). Throughout the lessons there was an integration of listening, speaking, reading, and writing.

The intervention consisted of Six Units. Each unit comprised seven days of instruction with the exception of Unit 1, which used only four days to build background. Each unit consisted of two days of morphological awareness, and five days of teaching core vocabulary and using the words in context. Each unit had two roots and two affixes and ten target words.

Day 1: word study, part 1: affixes

Day 2: word study, part 2: roots

Day 3: introducing the vocabulary

Day 4: deepening word knowledge

Day 5: using words in reading

Day 6: using words in oral language and writing

Day 7: review and quiz

All of the words were in the units were cognates that can be classified as general academic vocabulary. There are two types of academic vocabulary: 1) content specific words
used in different content areas such as science, mathematics and social studies – e.g. mitochondria or quadrilateral; and 2) general academic vocabulary, or words that appear across content areas but may vary in meaning across disciplines – e.g. factor or function (Bauman & Graves, 2010; Lubliner & Hiebert, 2008). This dissertation focuses on general academic vocabulary, which is important for students because these words that are commonly used across content areas and are often found in content area textbooks across disciplines, but are frequently overlooked for instruction because they are not seen as central to the content (Lubliner & Hiebert, 2008).

The intervention was intended to take place for forty days of continuous language arts instruction (50 min. periods). In reality, however, the intervention took place for 40 days and the instruction was not continuous. Due to the time of year (winter), there were vacation periods and severe unexpected winter weather that did not allow the instruction to be continuous.

Teachers received approximately 10 hours of professional development prior to implementing the interventions. During the time that the intervention took place, there were coaches assigned to the teachers. These coaches and other research assistants provided support for the teachers and conducted fidelity observations.

Two teachers were responsible for teaching the Words in Motion intervention to the students in the four 6th grade classrooms. One of the teachers (Spanish instruction) was a Spanish-English bilingual while the other (English instruction) was an English-speaking monolingual. The four classes switched language of instruction every other day; therefore, the interventions were being delivered using a complete bilingual approach. Days 1, 3, 5, and 7 were taught in English and days 2, 4, and 6 were taught in Spanish.

Participants

The longitudinal study sample was composed of 98 students who were in the 6th grade
during the 2010-2011 school year and in 7th grade during the 2011-2012 school year. Initially, only one 6th grade homeroom was selected by the principal investigators to participate in the study. The selection of the specific homeroom was based on the ratio of native Spanish and native English speakers, class size, schedule and the voluntary participation of the teachers. However, over the course of the study, the participating teachers revealed that they had decided to provide the intervention to all four 6th grade classes. As a result, I decided to collect longitudinal data on all four 6th grade homerooms. Therefore, this dissertation study incorporates data from students at New Beginnings School who were part of the EVoCA study as well as students who were given the intervention but were not originally part of the EVoCA study.

The students in the four classes formed a sample of 98 students (n= 98). Of the 98 students, 61 were female (62%). In addition, data from the home language survey administered by the EVoCA project, revealed that approximately 90% of the students were from Spanish speaking homes. Coincidentally, district records indicated that Spanish was the reported as the native language for 89% of the students. Student level data from school records also revealed that 50% of the students qualified for additional English Language services. A relatively small number of students, 9%, qualified for Special education services. In addition, the student data revealed that 90% of the students in the study qualified for free or reduced lunch. Table 2 gives you a more detailed breakdown of gender, first language information and ELL status by homeroom.

Table 2

Sample Demographics

<table>
<thead>
<tr>
<th>HR 1</th>
<th>HR 2</th>
<th>HR 3</th>
<th>HR 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>24</td>
<td>23</td>
<td>27</td>
<td>98</td>
</tr>
</tbody>
</table>
All of the students in the study were considered to be Spanish-English bilinguals. Although most of the students in this sample reported that Spanish was their L1, there was an equal number of students who were considered ELLs due to lack of proficiency in English. They were all required to attend classes in Spanish and English and had varied levels of proficiency in both languages by the time of onset of the study. Because of the clear lack of variability in the constructs of native language, free or reduced lunch eligibility, and qualification for special education services, it is clear from this description of the sample that these constructs would not be useful in the analyses moving forward.

This dissertation was divided into two studies to address vocabulary development in each language: Study 1 (English vocabulary development) and Study 2 (Spanish cognate development). Because these two studies have the same underlying structure, there may be some repetition throughout the text, particularly, in the sections following.

**Measures and Data Collection Procedures**

This dissertation study draws upon measures that were administered as part of the larger EVoCA study, two of which are pre-existing, standardized measures of English (DRA2) and
Spanish (EDL) reading comprehension, and two of which are researcher-developed English and Spanish vocabulary measures specific to the purposes of the larger study. Table 3 summarizes the assessments used for this dissertation. Following the table is more detailed information about each assessment.

The two researcher-developed vocabulary measures were each administered by trained project researchers four times over a period of twelve months: 1) May, 2011 (end of 6th grade); 2) September, 2011 (fall of 7th grade); 3) January, 2012 (winter of 7th grade); and 4) May 2012 (spring of 7th grade). Once collected, they were sent to the Center for Applied Linguistics (CAL) in Washington DC, where researchers scanned the response sheets into computerized spreadsheets and cleaned the data. At least 10% of the data was spot-checked against the paper tests to make sure that they had scanned correctly.

The two pre-existing measures were administered, by school personnel, as part of their annual assessment plan. These measures are usually administered twice during the school year. The first time is in the winter (January) and the second time is in the spring (May-June) (C. Morrell, personal communication on April 21, 2013). The school released the winter scores to project researchers at the Center for Applied Linguistics, who incorporated them into the project dataset.

The dataset was maintained on a secure network, and hard copies of assessments were stored in locked filing cabinets. All of the students were given identification numbers so that data could not be traced back to them. Student information remained confidential. Only project researchers had access to the linking information.

Table 3

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Construct</th>
<th>Language</th>
<th>Format</th>
<th>Standardized or</th>
<th>When</th>
</tr>
</thead>
</table>

Assessment Summary Chart
### English Vocabulary Test.

This whole-class administered assessment was designed to assess students' knowledge of both taught and non-taught cognates within the intervention, as well as additional non-taught, non-cognate words. The measure consists of 53 multiple-choice items with four answer choices each. Each item has a target word that is underlined and embedded in a simple sentence to provide minimal context. An example question is:

I interpreted the directions differently.

- understood
- copied
- organized
- repeated

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Language</th>
<th>Grade Level</th>
<th>Administration</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Multiple choice</td>
<td>53 Items</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Multiple choice</td>
<td>38 items</td>
</tr>
</tbody>
</table>
The estimated internal reliability was found to be very high (Cronbach’s alpha = .91). The criterion validity, using the Gates MacGinitie Vocabulary Test as a reference, was likewise found to be quite high (r=.81). This assessment was used as the dependent variable in the analyses for Study 1, and as an independent variable for Study 2.

**Spanish Cognate Test.**

This whole-class administered assessment was designed to assess students’ knowledge of taught cognates and non-taught cognates. The assessment consists of 38 multiple choice items with four answer choices, each presented bilingually (English translations are provided in parentheses). Each item has a target word that is underlined and embedded in a simple sentence to provide minimal context. Whereas the English vocabulary test is completed silently and independently, the items and Spanish choices in the Spanish vocabulary test are read aloud to students to ensure that limited Spanish literacy is not a hindrance to responding correctly. An example question is:

Cristina se **encuentra** en una situación difícil.

- irrita (gets angry)
- imagina (imagines herself)
- halla (finds herself)
- asusta (gets scared)

The estimated internal reliability was (Cronbach’s alpha = .78). The criterion validity, using the WLPBR vocabulary Test as a reference, was (r=.47). This assessment was used as a dependent variable in Study 2 and a covariate in Study 1.

**Developmental Reading Assessment (DRA2): Comprehension.**

The DRA2 is an individually administered assessment designed to assess the English reading engagement, oral reading fluency and comprehension of students. It provides
information to identify students’ independent reading levels. Although this assessment is inclusive of these three parts, only the comprehension score was used as baseline predictor of English literacy for all of the students because there were enough components in the comprehension part (questioning, prediction, summary, interpretation, metacognitive awareness, and reflection) to use it as a baseline predictor. The comprehension part of the assessment is completed by students independently in a one to one setting with the teacher. There is no time restriction for this assessment. For those students who are at a lower reading level, (40<), the students are required to read the first page or two of the book out loud to the teacher. The teacher will then ask the students some comprehension questions such as: What questions do you expect to be answered in this book?; Based on the title, what do you expect this story to be about? (C. Morrell, personal communication on April 21, 2013). If the students pass this part of the test, then they continue to read independently. If the students do not pass this part of the test, then the test stops. The students that are at a higher level (40 or above), are required to read the entire benchmark assessment book independently and respond to the questions and prompts after reading the entire book. Lastly, they report to the teacher who determines the students’ score. The scores for this part are calculated based on a rubric (Table 4). This same rubric is also used for the Evaluación del desarollo de la lectura (EDL). The total possible score for this part is 24 points. The test has internal consistency reliability scores that range from (Cronbach’s alpha 0.730 to 0.818), in comprehension based on field tests that were conducted in the spring of 2006 (DRA2 Technical Manual, 2011). The sample used to conduct the analysis consisted of 1676 students in grades K-8. This variable was included as a control in Study 1.

**Evaluación del Desarrollo de la Lectura (EDL): Comprehension.**
The EDL is an individually administered assessment designed to assess the Spanish reading engagement, oral reading fluency and comprehension of students. It provides information to identify students’ independent reading levels. Although this assessment is inclusive of these three parts, only the comprehension score was used as baseline predictor of Spanish literacy for all of the student because there were enough components in the comprehension part (questioning, prediction, summary, interpretation, metacognitive awareness, and reflection) to use it as a baseline predictor. The comprehension part of the assessment is completed by students independently in a one to one setting with the teacher. There is no time restriction for this assessment. For those students who are at a lower reading level, (40<), the students are required to read the first page or two of the book out loud to the teacher. The teacher will then ask the students some comprehension questions in Spanish such as: ¿Qué preguntas esperas que sean contestadas en esta historia o este libro? Basado en el título, ¿de qué esperas que se trate esta historia o este libro? (C. Villarini, personal communication on April 21, 2013). If the students pass this part of the test, then they continue to read independently. If the students do not pass this part of the test, then the test stops. The students that are at a higher level (40 or above), are required to read the entire benchmark assessment book independently and respond to the questions and prompts after reading the entire book. They report to the teacher who determines the students’ scores. The scores for this part are calculated based on a rubric (Table 4). The internal reliability scores for this test are not available from the publisher at this time (L. Cranfill, Pearson Education, personal communication on April 22, 2013). This variable was included as a control in Study 2.

Table 4

Comprehension Chart
<table>
<thead>
<tr>
<th>Quality</th>
<th>1 point</th>
<th>2 points</th>
<th>3 points</th>
<th>4 points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention</strong></td>
<td>Illogical or unrelated questions and/or predictions</td>
<td>1-2 reasonable questions and/or predictors that go beyond</td>
<td>At least 2 reasonable questions and predictions that go beyond the text read aloud</td>
<td>At least 3 thoughtful questions and predictions that go beyond the text read aloud</td>
</tr>
<tr>
<td><strong>Instructional</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Independent</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Advanced</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Questioning &amp; Prediction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>1-2 ideas/facts in own language and/or copied text; may include incorrect information</td>
<td>Partial summary; generally own language; some important ideas/facts; may include misinterpretations</td>
<td>Summary in own language; includes many important ideas, some vocabulary and supporting facts form each section</td>
<td>Summary in own language; includes all important ideas, key vocabulary, and supporting facts from each section</td>
</tr>
<tr>
<td><strong>Literal Comprehension</strong></td>
<td>Little information from the text and/or incorrect information</td>
<td>Partial information from the text; may include misinterpretation</td>
<td>Information from the text that accurately responds to questions or prompts.</td>
<td>All important information from the text that effectively responds to questions or prompts.</td>
</tr>
<tr>
<td><strong>Interpretation</strong></td>
<td>Little or no understanding of important text implications</td>
<td>Partial understanding of important text implications; little or no detail</td>
<td>Understands important text implications; relevant supporting details</td>
<td>Insightful understanding of important text implications; important supporting details</td>
</tr>
<tr>
<td><strong>Reflection</strong></td>
<td>Insignificant or unrelated message or information; no reason for opinion or no response</td>
<td>Less significant message or information and general reasons for opinion</td>
<td>Significant message or information and a relevant reason for opinion</td>
<td>Significant message or information and reasons for opinion that reflect higher level thinking.</td>
</tr>
<tr>
<td><strong>Metacognitive Awareness</strong></td>
<td>Unrelated or no examples; may copy a strategy</td>
<td>General or limited examples</td>
<td>At least 1 specific example from the text related to the identified strategy; may include details.</td>
<td>At least 2 specific examples from the text related to the identified strategy; includes details</td>
</tr>
<tr>
<td><strong>Score</strong></td>
<td>6 - 11</td>
<td>12 - 16</td>
<td>17 - 22</td>
<td>23 - 24</td>
</tr>
</tbody>
</table>

**ELL Status.**

A dummy variable was created to indicate whether or not a student was classified as ELL at the time of the study, with 0 indicating no and 1 indicating yes. This variable was included as an independent variable in Study 1 and Study 2.

**Data Analysis**

This was a developmental study that employed a growth curve analysis (Raudenbush & Bryk, 2002). Initially, descriptive statistics were calculated in order to get preliminary information for the students. Before constructing the growth models, the scores at all four data
points were observed to see if there were any preliminary indicators of growth. This was followed by the generation of unconditional and conditional growth models using hierarchical linear modeling or HLM. “HLM allows researchers to model multiple levels of a hierarchy simultaneously, partition variance across the levels of analysis, and examine relationships and interactions among variables that occur at multiple levels of a hierarchy” (McCoach & Adelson, 2010, p.153). The value of using HLM is that it allows one to analyze variance in outcome variables at multiple hierarchical levels such as time and students.

**Descriptive Statistics.**

Using analytical statistical procedures, data resulting from the assessments were examined. Data were entered into SPSS. Descriptive statistics (means, standard deviations, and ranges) were calculated for all assessments. Correlations were examined in order to observe the relationship between the Spanish Cognate Test and the English Vocabulary Test. For the descriptive statistics, SPSS was the only software used. However, in order to create growth models to answer the research questions, data were exported from SPSS into HLM (Raudenbush, et al., 2011).

**Hierarchical Linear Modeling.**

Due to the nested nature of the data, HLM was used as the primary analytic technique for all of the research questions. With HLM, each of the levels in the structure was formally represented by its own submodel. The submodels express relationships among variables within a given level and specify how variables at one level influence relations occurring at another. “In all quantitative research, it is essential that the variables under study have precise meaning so that the statistical results can be related to the theoretical concerns that motivate the research” (Raudenbush & Bryk, 2002, p.31). In the case of HLM, the intercept and the slopes in the level 1
model become outcome variables at level 2. It is essential that the meaning of these outcome
variables be clearly understood.

Because of the complex nature of growth modeling, I will discuss its evolution in a series
of steps. I will first describe the predictors and the coding that were used for each study. Next, I
will describe the growth models developed for each study.

**Study 1 - Variables**

The outcome/dependent variable for study 1 was the score on the English Vocabulary Test
(ENGLISH). The level one predictor/independent variable was MONTHS, which created a
longitudinal model; *(Level 1 TIME- Within individual change over time)*. MONTHS, was
reflective of the four data points during the study and was equivalent to TIME. The meaning of
the intercept in the level 1 model depends on the location of the level 1 predictor variables. It is
often useful to center the variable. MONTHS was centered at the data point in May 2011
therefore May 2011 was coded (0), September 2011 was coded (4), January 2012 was coded (8)
and May 2012 was coded (12). The goal of a level 1 analysis was to describe the shape of each
The level two predictors were INITSPAN, ELL and DRA; (Level 2 STUDENTS- Inter-individual differences in change). First, the initial Spanish score from the Spanish Cognate test (INITSPAN) was a non-time varying predictor in the model. This predictor was used to investigate potential cross-linguistic influence in English vocabulary development; in other words, to explore to what extent, if at all, initial status and/or rate of change in English vocabulary ability varies by initial Spanish cognate knowledge. Second, the comprehension component of the Developmental Reading Assessment scores (DRA2) was used as a non-time varying predictor. DRA was the variable name for the DRA2 assessment. INITSPAN and DRA were centered around the grand mean. Lastly, out of 98 students, 49 of them were classified by the school as ELL and 49 were classified as NON ELL. Using this information, a dummy variable was created where ELL=1 and NON-ELL = 0. ELL status was included in the model in order to determine if being an ELL had an effect on the outcome variable. The goal of a level 2 analysis was to detect systematic heterogeneity in initial status and change across individuals and to determine the relationship between predictors and the shape of each person’s individual growth trajectory. The Level 2 model was developed to see if students began with varying levels of English vocabulary knowledge and showed different patterns of growth based on English reading comprehension, initial Spanish cognate knowledge, and/or ELL status. Table 5 below shows the predictors for study 1 and how they were coded.

Table 5

<table>
<thead>
<tr>
<th>Study 1 Level</th>
<th>Predictor Name</th>
<th>Code</th>
</tr>
</thead>
</table>

Study 1 – Predictor and Coding Chart
<table>
<thead>
<tr>
<th></th>
<th>MONTHS</th>
<th>MONTHS was centered at the first data point in May 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Was reflective of the 4 data points</td>
<td>• May 2011 was coded (0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sept. 2011 was coded (4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Jan. 2012 was coded (8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• May 2012 was coded (12)</td>
</tr>
<tr>
<td>2</td>
<td>ELL &amp; NON ELL</td>
<td>Coded 0 if NON ELL</td>
</tr>
<tr>
<td></td>
<td>• English Language Learner Status</td>
<td>Coded 1 if ELL</td>
</tr>
<tr>
<td>2</td>
<td>INITSPAN</td>
<td>These scores were grand mean centered.</td>
</tr>
<tr>
<td></td>
<td>• Initial Spanish scores for Spanish Cognate test</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Were used to look at the influence across languages</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>DRA</td>
<td>These scores were grand mean centered.</td>
</tr>
<tr>
<td></td>
<td>• Used as a universal pre-test of English literacy for all students</td>
<td></td>
</tr>
</tbody>
</table>

**Research Questions and Data Analysis Procedures**

**Research Question 1a:** What are the initial status and the rate of change of English academic vocabulary development among Spanish-English bilingual students from the end of 6th grade to the end of 7th grade?

**Data Analysis Procedures – Building a Taxonomy of Unconditional Models.**

In order to investigate question 1a, I built a taxonomy of unconditional growth models. In Model 1, I built a standard unconditional model allowing variation within and across individuals.
However, as will be discussed in greater detail in Chapter 4, this model yielded the finding that there was no significant variation across students with regard to rate of change of English vocabulary. As a result, I decided to eliminate the student-level slope residual from the final model, which resulted in a better fit (Model 2). This model building process is described below.

**Model 1 - The Unconditional Model.**

In order to investigate the initial status and the rate of change of English academic vocabulary from the end of grade 6 to the end of grade 7 for all students in the study, an unconditional model with no predictors was built. This model provided an average initial status for all students and an average rate of change for all students. An unconditional model was constructed to show if the coefficient was statistically significantly associated with the outcome (English vocabulary knowledge) without knowing anything about the students. If the p-value of the intercept ($\pi_0$) is statistically significant, then we know that the intercept is probably not 0. If the p-value for the slope ($\pi_1$) is statistically significant, it means that students’ scores are changing across months. The random effects provided information regarding whether the starting ability and the growth were different for different students. The random effects output provides information regarding whether or not the variance is statistically significant from 0 or not, which allows us to determine if there is variability. Model 1- is expressed as follows:

**Level-1 Model**

$$ENGLISH_{ti} = \pi_{0i} + \pi_{1i} \times (MONTHS_{ti}) + e_{ti}$$

**Level-2 Model**

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

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

**Mixed Model**
Each student (n=98) has one equation at level 1. This level 1 model equation is used to describe the scores within the person where \((ENGLISH)_{it}\) is the outcome (i.e., English vocabulary score) at time \(t\) for student \(i\), \(\pi_{oi}\) is the estimated initial status of student \(i\), \(\pi_{1i}\) (MONTHS) shows the change of English scores over time for person \(i\), \(e_{ii}\) is a residual term representing unexplained variation from the growth trajectory at level 1 for person \(i\).

\[
ENGLISH_{it} = \pi_{0i} + \pi_{1i} \times (MONTHS)_{it} + e_{it}.
\]

Level 2 will try to predict if the coefficients are the same or different for different students. The intercept \((\pi_{0i})\) and slope \((\pi_{1i})\) of students will be modeled as well as residuals representing unexplained student level variation in both the intercept \((r_{0i})\) and the slope \((r_{1i})\). The equations below specify the level-2 model.

\[
\pi_{0i} = \beta_{00} + r_{0i}, \quad \pi_{1i} = \beta_{10} + r_{1i},
\]

In the mixed model, there is a combination of Level 1 equations and Level 2 equations. This was accomplished by substituting Level 2 equations into the Level 1 model, as follows:

\[
ENGLISH_{it} = \beta_{00} + \beta_{10} \times (MONTHS)_{it} + r_{0i} + r_{1i} \times (MONTHS)_{it} + e_{it}
\]

Here, \(\beta_{00}\) is the average intercept (initial status) of all students, and \(\beta_{10}\) is the average slope (rate of change) for all students, while \(r_{0i}\) is the person level residual for the intercept and \(r_{1i}\) is the person level residual for the slope.

**Model 2 - The Unconditional Model Without the Residual for the Slopes.**

Because the first unconditional model showed that the slopes did not vary across students, the decision was made to remove the student-level residual for the slopes. It was best to constrain the values at zero, therefore eliminating the residual variance of the slope and the residual
covariance between the slope and the intercept as parameters to be estimated. This unconditional model (Model 2) is the final model for question 1a, and is also the model used in the creation of a taxonomy of models to explore question 1b. Model 2 is expressed as follows:

**Level-1 Model**

\[ ENGLISH_{ti} = \pi_{0i} + \pi_{1i} \times (MONTHS_{ti}) + e_{ti} \]

**Level-2 Model**

\[ \pi_{0i} = \beta_{00} + r_{0i} \]
\[ \pi_{1i} = \beta_{10} \]

**Mixed Model**

\[ ENGLISH_{ti} = \beta_{00} + \beta_{10} \times MONTHS_{ti} + r_{0i} + e_{ti} \]

Here, all of the descriptions of the Model 1 parameters apply. The one difference is that the student-level residual has been removed from the Level-2 slope model (\( \pi_{1i} = \beta_{10} \)), and as a result, from the Mixed Model as well.

**Research Question 1b:** Controlling for English reading comprehension ability, do initial status and/or rate of change of English academic vocabulary development vary according to ELL status and Spanish cognate knowledge?

**Data Analysis Procedures – Building a Taxonomy of Conditional Models.**

In order to investigate if the initial status and rate of change of English vocabulary knowledge vary according to ELL status and Spanish cognate ability after controlling for English reading comprehension ability, I developed a taxonomy of conditional growth models to test the effects of these variables independently of one another and together. I used Model 2, the
unconditional model with no student-level residual variance for the slope, as the point of departure for the creation of this taxonomy of conditional models.

Model 3 was created by adding the English reading comprehension score (DRA) as a control variable for initial status. Model 4 starts with Model 3 as a point of departure, with the student level predictor ELL added. Model 5 again uses Model 3 as a point of departure, this time incorporating the predictor variable INITSPAN in place of ELL. This model revealed once again that DRA was not statistically significant. The last model, Model 6, draws upon the results of Models 3-5 and drops the control variable DRA, which was not significantly associated with either the intercept or the slope in any of the models, and incorporates only the two predictors ELL and INITSPAN. Each model in the taxonomy is described in detail below.

**Model 3 - The Conditional Model with Student Level Predictor DRA.**

The student-level control variable DRA (which was grand-mean centered) was added to the Level 2 models for the intercept to investigate the potential effects on the initial status of English vocabulary knowledge, respectively. The models are expressed as follows:

**Level-1 Model**

\[ ENGLISH_{i} = \pi_{0i} + \pi_{1i} \cdot (MONTHS_{i}) + e_{ii} \]

**Level-2 Model**
\[ \pi_{0i} = \beta_{00} + \beta_{01} \ast (DRA) + r_{0i} \]

\[ \pi_{1i} = \beta_{10} \]

In the Level-2 intercept model, \( \pi_{0i} \) represents the estimated initial ENGLISH vocabulary ability for person \( i \), which is expressed as a function of \( \beta_{00} \) – the average English vocabulary intercept (initial status) across all students plus the effect of the DRA on initial English vocabulary ability (\( \beta_{01} \)), plus a student-level residual (\( r_{0i} \)). In the Level-2 slope model, \( \pi_{1i} \) represents the estimated rate of change in ENGLISH vocabulary ability for person \( i \), which is expressed simply as \( \beta_{10} \) – the average English vocabulary slope (rate of change) across all students, which as determined in Model 1, does not vary significantly across students, thus eliminating the need for a student-level residual in the Level-2 model. These parameters are then combined in the Mixed Model as follows:

**Mixed Model**

\[ ENGLISH_{ii} = \beta_{00} + \beta_{01} \ast DRA_{i} + \beta_{10} \ast MONTHS_{ii} + r_{0i} + e_{ii} \]

**Model 4 - The Conditional Model With DRA & ELL.**

The student-level control variable ELL was added to the Level 2 models for the intercept to investigate the potential effects on the initial status of English vocabulary knowledge, respectively. The models are expressed as follows:

**Level-1 Model**

\[ ENGLISH_{ii} = \pi_{0i} + \pi_{1i} \ast (MONTHS_{ii}) + e_{ii} \]
**Level-2 Model**

\[
\pi_{0i} = \beta_{00} + \beta_{01}(ELL_i) + \beta_{02}(DRA_i) + r_{0i}
\]

\[
\pi_{1i} = \beta_{10}
\]

In the Level-2 intercept model, \(\pi_{0i}\) represents the estimated initial ENGLISH vocabulary ability for person i, which is expressed as a function of \(\beta_{00}\) – the average English vocabulary intercept (initial status) across all students plus the effect of the ELL on initial English vocabulary ability (\(\beta_{01}\)), plus the effect of the DRA on initial English vocabulary ability (\(\beta_{02}\)), plus a student-level residual (\(r_{0i}\)). In the Level-2 slope model, \(\pi_{1i}\) represents the estimated rate of change in ENGLISH vocabulary ability for person i, which is expressed simply as \(\beta_{10}\) – the average English vocabulary slope (rate of change) across all students, which as determined in Model 1, does not vary significantly across students, thus eliminating the need for a student-level residual in the Level-2 model. These parameters are then combined in the Mixed Model as follows:

**Mixed Model**

\[
ENGLISH_{ti} = \beta_{00} + \beta_{01}ELL_i + \beta_{02}DRA_i + \beta_{10}MONTHS_{ti} + r_{0i} + e_{ti}
\]

**Model 5 - The Conditional Model With DRA & INITSPAN.**

The student-level control variable INITSPAN (which was grand-mean centered) was added to the Level 2 models for the intercept to investigate the potential effects on the initial status of English vocabulary knowledge, respectively. The models are expressed as follows:

**Level-1 Model**

\[
ENGLISH_{i} = \pi_{0i} + \pi_{1i}(MONTHS_{i}) + e_{ti}
\]
**Level-2 Model**

\[ \pi_{oi} = \beta_{00} + \beta_{01} \cdot (DRA_i) + \beta_{02} \cdot (INITSPAN_i) + r_{0i} \]

\[ \pi_{ii} = \beta_{10} \]

In the Level-2 intercept model, \( \pi_{oi} \) represents the estimated initial ENGLISH vocabulary ability for person i, which is expressed as a function of \( \beta_{00} \) – the average English vocabulary intercept (initial status) across all students plus the effect of the DRA on initial English vocabulary ability (\( \beta_{01} \)), plus the effect of the INITSPAN on initial English vocabulary ability (\( \beta_{02} \)), plus a student-level residual (\( r_{0i} \)). In the Level-2 slope model, \( \pi_{ii} \) represents the estimated rate of change in ENGLISH vocabulary ability for person i, which is expressed simply as \( \beta_{10} \) – the average English vocabulary slope (rate of change) across all students, which as determined in Model 1, does not vary significantly across students, thus eliminating the need for a student-level residual in the Level-2 model. These parameters are then combined in the Mixed Model as follows:

**Mixed Model**

\[ ENGLISH_i = \beta_{00} + \beta_{01} \cdot DRA_i + \beta_{02} \cdot INITSPAN_i + \beta_{10} \cdot MONTHS_i + r_{0i} + e_{ii} \]

**Model 6 - The Conditional Model With Both ELL and INITSPAN.**

The student-level control variable DRA was deleted from the models because up to this point, it had not shown any statistical significance. The student-level control variables ELL and INITSPAN were both added to the Level 2 models for the intercept investigate the potential effects on the initial status of English vocabulary knowledge, respectively. The models are expressed as follows:

**Level-1 Model**
\[ ENGLISH_{it} = \pi_{0i} + \pi_{1i}*(MONTHS_{it}) + e_{it} \]

**Level-2 Model**

\[
\pi_{0i} = \beta_{00} + \beta_{01}*(ELL_{i}) + \beta_{02}*(INITSPAN_{i}) + r_{0i} \\
\pi_{1i} = \beta_{10}
\]

In the Level-2 intercept model, \(\pi_{0i}\) represents the estimated initial ENGLISH vocabulary ability for person \(i\), which is expressed as a function of \(\beta_{00}\) – the average English vocabulary intercept (initial status) across all students plus the effect of the ELL on initial English vocabulary ability (\(\beta_{01}\)), plus the effect of the INITSPAN on initial English vocabulary ability (\(\beta_{02}\)), plus a student-level residual (\(r_{0i}\)). In the Level-2 slope model, \(\pi_{1i}\) represents the estimated rate of change in ENGLISH vocabulary ability for person \(i\), which is expressed simply as \(\beta_{10}\) – the average English vocabulary slope (rate of change) across all students, which as determined in Model 1, does not vary significantly across students, thus eliminating the need for a student-level residual in the Level-2 model. These parameters are then combined in the Mixed Model as follows:

**Mixed Model**

\[ ENGLISH_{it} = \beta_{00} + \beta_{01}*(ELL_{i}) + \beta_{02}*(INITSPAN_{i}) + \beta_{10}*(MONTHS_{it}) + r_{0i} + e_{it} \]

**Study 2 - Variables**

The outcome/dependent variable for study 2 was the score on the Spanish Cognate test (SPANISH). The level one predictor/independent variable was MONTHS, which created a longitudinal model; *(Level 1 TIME- Within individual change over time).* MONTHS was reflective of the four data points during the study and was equivalent to TIME. The meaning of the intercept in the level 1 model depends on the location of the level 1 predictor variables. It is often useful to center the variable. MONTHS, was centered at the data point in May 2011;
therefore, May 2011 was coded (0), September 2011 was coded (4), January 2012 was coded (8) and May 2012 was coded (12). The goal of a level 1 analysis was to describe the shape of each person’s individual growth trajectory and to examine within-person variability.

The level two predictors were INITENG, ELL and EDL; (*Level 2 STUDENTS- Inter-individual differences in change*). First, the initial English score from the EVoCA English test or (INITENG) was a non-time varying predictor in the model. This predictor was used to investigate potential cross-linguistic influence in Spanish vocabulary development; in other words, to explore to what extent, if at all, initial status and/or rate of change in Spanish vocabulary ability varies by initial English knowledge. Second, the comprehension component of the Evaluacion del Desarrollo de Lectura scores (EDL) was used as non-time varying predictor. INITENG and EDL were centered around the grand mean. Lastly, out of 98 students, 49 of them were classified by the school as ELL and 49 were classified as NON ELL. Using this information, a dummy variable was created where ELL = 1 and NON ELL = 0. ELL status was included in the model in order to determine if being an ELL had an effect on the outcome variable. The goal of a level 2 analysis was to detect heterogeneity in change across individuals and to determine the relationship between predictors and the shape of each person’s individual growth trajectory. The Level 2 model was developed to see if students began with varying levels of Spanish cognate vocabulary knowledge and showed different patterns of growth based on Spanish reading comprehension, initial English vocabulary knowledge, and/or ELL status. Table 6 below shows the predictors for study 2 and how they were coded.

Table 6

*Study 2 – Predictor and Coding Chart*

<table>
<thead>
<tr>
<th>Study Level</th>
<th>Predictor Name</th>
<th>Code</th>
</tr>
</thead>
</table>

50
<table>
<thead>
<tr>
<th></th>
<th>MONTHS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Was reflective of the 4 data points</td>
<td>MONTHS was centered at the first data point in May 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May 2011 was coded (0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sept. 2011 was coded (4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jan. 2012 was coded (8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May 2012 was coded (12)</td>
</tr>
<tr>
<td>2</td>
<td>ELL &amp; NON ELL</td>
<td>Coded 0 if NON ELL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coded 1 if ELL</td>
</tr>
<tr>
<td>2</td>
<td>INITENG</td>
<td>These scores were grand mean centered.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Initial English scores for English Vocabulary test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Used to look at the influence across languages</td>
</tr>
<tr>
<td>2</td>
<td>EDL</td>
<td>These scores were grand mean centered.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Used as a universal pre-test of Spanish literacy for all of the students.</td>
</tr>
</tbody>
</table>

Research Questions and Data Analysis Procedures

**Research Question 2a:** What are the initial status and the rate of change of Spanish cognate vocabulary among Spanish-English bilingual students from the end of 6th grade to the end of 7th grade?

**Data Analysis Procedures – Building a Taxonomy of Unconditional Models.**
In order to investigate question 2a, I built a taxonomy of unconditional growth models. In Model 1, I built a standard unconditional model allowing variation within and across individuals. However, as will be discussed in greater detail in Chapter 4, this model yielded the finding that there was no significant variation across students with regard to rate of change of Spanish vocabulary. As a result, I decided to eliminate the student-level slope residual from the final model, which resulted in a better fit (Model 2). This model building process is described below.

**Model 1- The Unconditional Model.**

In order to investigate the initial status and the rate of change of Spanish academic vocabulary from the end of grade 6 to the end of grade 7 for all students in the study, an unconditional model with no predictors was built. This model provided an average initial status for all students and an average rate of change for all students. An unconditional model was constructed to show if the coefficient was statistically significantly associated with the outcome (Spanish vocabulary knowledge) without knowing anything about the students. If the p-value of the intercept \( \pi_0 \) is statistically significant, then we know that the intercept is probably not 0. If the p-value for the slope \( \pi_1 \) is statistically significant, it means that students’ scores are changing across months. The random effects provided information regarding whether the starting ability and the growth were different for different students. The random effects output provides information regarding whether or not the variance is statistically significant from 0 or not, which allows us to determine if there is variability. The best fit model to answer question 1a was: Model 1- The unconditional model, which is expressed as follows:

**Level-1 Model**

\[
SPANISH_{it} = \pi_{0i} + \pi_{1i} \times (MONTHS_{it}) + e_{it}
\]

**Level-2 Model**
$\pi_{0i} = \beta_{00} + r_{0i}$
$\pi_{1i} = \beta_{10} + r_{1i}$

**Mixed Model**

$SPANISH_{ti} = \beta_{00} + \beta_{10}*MONTHS_{ti} + r_{0i} + r_{1i}*MONTHS_{ti} + e_{ti}$

Each student (n=98) has one equation at level 1. This level 1 model equation is used to describe the scores within the person where (SPANISH)$_{ti}$ is the outcome (i.e., Spanish score) at time $t$ for student $i$, $\pi_{0i}$ is the estimated initial status of student $i$, $\pi_{1i}$ (MONTHS) shows the change of Spanish scores over time for person $i$, $e_{ti}$ is a residual term representing unexplained variation from the growth trajectory at level 1 for person $i$.

$SPANISH_{ti} = \pi_{0i} + \pi_{1i}*(MONTHS_{ti}) + e_{ti}$.

Level 2 predicted if the coefficients were the same or different for different students. The intercept ($\pi_{0i}$) and slope ($\pi_{1i}$) of students will be modeled as well as residuals representing unexplained student level variation in both the intercept ($r_{0i}$) and the slope ($r_{1i}$). The equations below specify the level-2 model.

$\pi_{0i} = \beta_{00} + r_{0i}$
$\pi_{1i} = \beta_{10} + r_{1i}$

In the mixed model, there is a combination of Level 1 equations and Level 2 equations. This was accomplished by substituting Level 2 equations into the Level 1 model, as follows:

$SPANISH_{ti} = \beta_{00} + \beta_{10}*MONTHS_{ti} + r_{0i} + r_{1i}*MONTHS_{ti} + e_{ti}$

Here, $\beta_{00}$ is the average intercept (initial status) of all students, and $\beta_{10}$ is the average slope (rate of change) for all students, while $r_{0i}$ is the person level residual for the intercept and $r_{1i}$ is the person level residual for the slope.

**Model 2 - The Unconditional Model Without the Residual for the Slopes.**
Because the first unconditional model showed that the slopes did not vary across students, the decision was made to remove the student-level residual for the slopes. It was best to constrain the values at zero; therefore, eliminating the residual variance of the slope and the residual covariance between the slope and the intercept as parameters to be estimated. This unconditional model (Model 2) is the final model for question 2a, and is also the model used in the creation of a taxonomy of models to explore question 2b. Model 2 is expressed as follows:

**Level-1 Model**

$$SPANISH_{ti} = \pi_{0i} + \pi_{1i} \times (MONTHS_{ti}) + e_{ti}$$

**Level-2 Model**

$$\pi_{0i} = \beta_{00} + r_{0i}$$
$$\pi_{1i} = \beta_{10}$$

**Mixed Model**

$$SPANISH_{ti} = \beta_{00} + \beta_{10} \times MONTHS_{ti} + r_{0i} + e_{ti}$$

Here, all of the descriptions of the Model 1 parameters apply. The one difference is that the student-level residual has been removed from the Level-2 slope model ($\pi_{1i} = \beta_{10}$), and as a result, from the Mixed Model as well.

**Research Question 2b:** Controlling for Spanish reading comprehension ability, do initial status and/or rate of change of Spanish cognate vocabulary vary according to ELL status and English vocabulary ability?

**Data Analysis Procedures – Building a Taxonomy of Conditional Models.**

In order to investigate if the initial status and rate of change of Spanish vocabulary
knowledge vary according to ELL status and Spanish cognate ability after controlling for Spanish reading comprehension ability, I developed a taxonomy of conditional growth models to test the effects of these variables independently of one another and together. I used Model 2, the unconditional model with no student-level residual variance for the slope, as the point of departure for the creation of this taxonomy of conditional models.

Model 3 was created by adding the Spanish reading comprehension score (EDL) as a control variable for initial status. Model 4 starts with Model 3 as a point of departure, with the student level predictor ELL added. Model 5 again uses Model 3 as a point of departure, this time incorporating the predictor variable INITENG in place of ELL. Model 6 was built using all predictors EDL, ELL and INITENG. Since ELL was significant in Model 4, and EDL and INITENG were significant in Model 5, I wanted to further explore if these three predictors together would have an effect on the Spanish EVoCA. Model 6 revealed that INITENG and EDL were statistically significant but ELL was no longer significant; therefore, intriguing me to further explore this interaction. Model 7 was built and all three predictor, EDL, ELL and INITENG were included along with a new interaction term ENGXELL. Interestingly, the EDL and INITENG were both statistically significant but ELL and the interaction term ENGXELL were not statistically significant.

Model 3 - The Conditional Model with EDL.

The student-level control variable EDL (which was grand-mean centered) was added to the Level 2 models for the intercept to investigate the potential effects on the initial status of English vocabulary knowledge, respectively. The models are expressed as follows:

Level-1 Model
SPANISH\textsubscript{\textit{i}} = \pi_{0i} + \pi_{1i}(MONTHS_{i}) + e_{\textit{i}}

**Level-2 Model**

\[
\pi_{0i} = \beta_{00} + \beta_{01}(EDLCOMP_{i}) + r_{0i}
\]

\[
\pi_{1i} = \beta_{10}
\]

In the Level-2 intercept model, \(\pi_{0i}\) represents the estimated initial Spanish vocabulary ability for person \(i\), which is expressed as a function of \(\beta_{00}\)—the average Spanish vocabulary intercept (initial status) across all students plus the effect of the EDL on initial English vocabulary ability (\(\beta_{01}\)), plus a student-level residual (\(r_{0i}\)). In the Level-2 slope model, \(\pi_{1i}\) represents the estimated rate of change in SPANISH vocabulary ability for person \(i\), which is expressed simply as \(\beta_{10}\)—the average Spanish vocabulary slope (rate of change) across all students, which as determined in Model 1, does not vary significantly across students, thus eliminating the need for a student-level residual in the Level-2 model. These parameters are then combined in the Mixed Model as follows:

**Mixed Model**

\[
SPANISH_{\textit{i}} = \beta_{00} + \beta_{01}*EDLCOMP_{i} + \beta_{10}*MONTHS_{\textit{i}} + r_{0i} + e_{\textit{i}}
\]

**Model 4 - The Conditional Model with EDL and ELL.**

The student-level control variables EDL and ELL were added to the Level 2 models for the intercept to investigate the potential effects on the initial status of English vocabulary knowledge, respectively. The models are expressed as follows:
Level-1 Model

\[ \text{SPANISH}_{i} = \pi_{0i} + \pi_{1i}(\text{MONTHS}_{i}) + e_{ni} \]

Level-2 Model

\[ \pi_{0i} = \beta_{00} + \beta_{01}(\text{ELL}_{i}) + \beta_{02}(\text{EDLCOMP}_{i}) + r_{0i} \]
\[ \pi_{1i} = \beta_{10} \]

In the Level-2 intercept model, \( \pi_{0i} \) represents the estimated initial Spanish vocabulary ability for person \( i \), which is expressed as a function of \( \beta_{00} \) – the average Spanish vocabulary intercept (initial status) across all students plus the average effect of the ELL on initial English vocabulary ability (\( \beta_{01} \)), plus the effect of the EDLCOMP on initial English vocabulary ability (\( \beta_{02} \)), plus a student-level residual (\( r_{0i} \)). In the Level-2 slope model, \( \pi_{1i} \) represents the estimated rate of change in SPANISH vocabulary ability for person \( i \), which is expressed simply as \( \beta_{10} \) – the average Spanish vocabulary slope (rate of change) across all students, which as determined in Model 1, does not vary significantly across students, thus eliminating the need for a student-level residual in the Level-2 model. These parameters are then combined in the Mixed Model as follows:

Mixed Model

\[ \text{SPANISH}_{i} = \beta_{00} + \beta_{01}\text{ELL}_{i} + \beta_{02}\text{EDLCOMP}_{i} + \beta_{10}\text{MONTHS}_{i} + r_{0i} + e_{ni} \]

Model 5 - The Conditional Model with EDL & INITENG (removed ELL).

The student-level control variables EDL and INITENG (which were both grand-mean centered) were added to the Level 2 models for the intercept to investigate the potential effects on the initial status of English vocabulary knowledge, respectively. The models are expressed as
follows:

**Level-1 Model**

\[ SPANISH_{it} = \pi_{0i} + \pi_{it} \cdot (MONTHS_{it}) + e_{it} \]

**Level-2 Model**

\[ \pi_{0i} = \beta_{00} + \beta_{01} \cdot (EDLCOMP_{i}) + \beta_{02} \cdot (INITENG_{i}) + r_{0i} \]

\[ \pi_{1i} = \beta_{10} \]

In the Level-2 intercept model, \( \pi_{0i} \) represents the estimated initial Spanish vocabulary ability for person \( i \), which is expressed as a function of \( \beta_{00} \) – the average Spanish vocabulary intercept (initial status) across all students plus the effect of the EDLCOMP on initial Spanish vocabulary ability (\( \beta_{01} \)), plus the effect of the INITENG on initial Spanish vocabulary ability (\( \beta_{02} \)), plus a student-level residual (\( r_{0i} \)). In the Level-2 slope model, \( \pi_{1i} \) represents the estimated rate of change in SPANISH vocabulary ability for person \( i \), which is expressed simply as \( \beta_{10} \) – the average Spanish vocabulary slope (rate of change) across all students, which as determined in Model 1, does not vary significantly across students, thus eliminating the need for a student-level residual in the Level-2 model. These parameters are then combined in the Mixed Model as follows:

**Mixed Model**

\[ SPANISH_{it} = \beta_{00} + \beta_{01} \cdot EDLCOMP_{i} + \beta_{02} \cdot INITENG_{i} + \beta_{10} \cdot MONTHS_{it} + r_{0i} + e_{it} \]

**Model 6 - The Conditional Model with EDL, ELL & INITENG.**

The student-level control variables EDL, ELL and INITENG were added to the Level 2 models for the intercept to investigate the potential effects on the initial status of Spanish vocabulary knowledge, respectively. The models are expressed as follows:
Level-1 Model

\[ SPANISH_i = \pi_{0i} + \pi_{1i}(MONTHS_i) + e_i \]

Level-2 Model

\[ \pi_{0i} = \beta_{00} + \beta_{01}(ELL_i) + \beta_{02}(EDLCOMP_i) + \beta_{03}(INITENG_i) + r_{0i} \]
\[ \pi_{1i} = \beta_{10} \]

In the Level-2 intercept model, \( \pi_{0i} \) represents the estimated initial SPANISH vocabulary ability for person \( i \), which is expressed as a function of \( \beta_{00} - \) the average Spanish vocabulary intercept (initial status) across all students plus the effect of the ELL on initial Spanish vocabulary ability (\( \beta_{01} \)), plus the effect of the EDLCOMP on initial Spanish vocabulary ability (\( \beta_{02} \)), plus the average effect of the INTENG on initial Spanish vocabulary ability (\( \beta_{03} \)), plus a student-level residual (\( r_{0i} \)). In the Level-2 slope model, \( \pi_{1i} \) represents the estimated rate of change in SPANISH vocabulary ability for person \( i \), which is expressed simply as \( \beta_{10} - \) the average Spanish vocabulary slope (rate of change) across all students, which as determined in Model 1, does not vary significantly across students, thus eliminating the need for a student-level residual in the Level-2 model. These parameters are then combined in the Mixed Model as follows:

Mixed Model

\[ SPANISH_i = \beta_{00} + \beta_{01}ELL_i + \beta_{02}EDLCOMP_i + \beta_{03}INITENG_i + \beta_{10}MONTHS_i + r_{0i} + e_{ni} \]

Model 7 - The Conditional Model with EDL, ELL, INITENG & (ENGXELL).

The student-level control variables EDL, ELL and INITENG and the interaction term SPANXELL were added to the Level 2 models for the intercept to investigate the potential effects on the initial status of Spanish vocabulary knowledge, respectively. The models are expressed as follows:
Level-1 Model

\[ SPANISH_{ij} = \beta_{0j} + \beta_{1j} \times (MONTHS_{ij}) + r_{ij} \]

Level-2 Model

\[ \beta_{0j} = \gamma_{00} + \gamma_{01} \times (ELL_j) + \gamma_{02} \times (EDLCOMP_j) + \gamma_{03} \times (INITENG_j) + \gamma_{04} \times (ENGXELL_j) + u_{0j} \]
\[ \beta_{1j} = \gamma_{10} \]

In the Level-2 intercept model, \( \pi_{oi} \) represents the estimated initial SPANISH vocabulary ability for person \( i \), which is expressed as a function of \( \beta_{00} \) – the average Spanish vocabulary intercept (initial status) across all students plus the effect of the ELL on initial Spanish vocabulary ability (\( \gamma_{01} \)), plus the effect of the EDLCOMP on initial Spanish vocabulary ability (\( \gamma_{02} \)), plus the effect of the INTENG on initial Spanish vocabulary ability (\( \gamma_{03} \)), plus the effect of the interaction ENGXELL on initial Spanish vocabulary ability (\( \gamma_{04} \)), plus a student-level residual (\( r_{0i} \)). In the Level-2 slope model, \( \beta_{1j} \) represents the estimated rate of change in SPANISH vocabulary ability for person \( i \), which is expressed simply as \( \gamma_{10} \) – the average Spanish vocabulary slope (rate of change) across all students, which as determined in Model 1, does not vary significantly across students, thus eliminating the need for a student-level residual in the Level-2 model. These parameters are then combined in the Mixed Model as follows:

Mixed Model

\[ SPANISH_{ij} = \gamma_{00} + \gamma_{01} \times ELL_j + \gamma_{02} \times EDLCOMP_j + \gamma_{03} \times INITENG_j + \gamma_{04} \times ENGXELL_j + \gamma_{10} \times MONTHS_{ij} + u_{0j} + r_{ij} \]

Summary

Hierarchical linear modeling was used as a method to identify average initial status and
average rate of change of both English vocabulary knowledge and Spanish cognate knowledge. In addition, the approach identified predictors that explain variance in the initial status of English vocabulary knowledge and Spanish cognate knowledge. Specifically, in study 1, controlling for English reading comprehension ability (DRA), I constructed a taxonomy of HLM models to determine if initial status varied according to ELL status and Spanish cognate ability. In study 2, controlling for Spanish reading comprehension ability (EDL), I created a taxonomy of models to determine if the initial status varied according to ELL status and English vocabulary ability. Hopefully, the findings from this study will give educators a better understanding of the vocabulary development Spanish-English bilingual students from the end of 6th grade to the end of 7th grade. The need for this research was introduced in Chapters one and two. Chapter three explained the methodology of the study in detail. Chapter four will describe the results of the analyses. Lastly, Chapter five will discuss the findings, describe the limitations, and give suggestions for future research.

CHAPTER 4

RESULTS

Introduction

In Chapter three, I provided a detailed overview of the participants, setting, assessments, and procedures for data collection and data analysis for this study. Following the approach laid out in that chapter, I begin Chapter 4 with a descriptive exploration of the outcomes, predictors,
and control variables that include descriptive statistics, correlations, mean growth trends and individual empirical trajectories. Using the same organizational structure developed in Chapter 3, I then share the results of the taxonomy of hierarchical linear models created to respond to research questions 1a and 1b (Study 1) and 2a and 2b (Study 2).

**Descriptive Statistics**

**English Vocabulary Test.**

The English Vocabulary Test assessed the vocabulary knowledge of taught cognates and non-taught cognates, as well as non-taught non-cognates. The mean total score of the English Vocabulary Test was 23.77 points (SD 9.6) out of a possible 53 points at data point 1. The mean total score at data point 2 was 24.59 points (SD 10.6). The mean total score at data point 3 was 26.48 points (SD 10.4). The mean total score at data point 4 was 28.62 points (SD 10.5). The graphs in the figures below suggest that they are normally distributed but with some slight positive skew in the first two data points. Here, as was the case with the Spanish cognate test, mean scores are never anywhere close to ceiling, showing the potential for much more growth on the measure. In addition, unlike the case with the Spanish cognate test, there is not a summer drop-off between time 1 and time 2, but rather, a slight but steady increase in scores at each subsequent data point. This foreshadows at least the potential for significant growth in English vocabulary knowledge.

*Figure 1. Distribution of Total Correct on English Vocabulary Post-test 1*
Figure 2. Distribution of Total Correct on English Vocabulary Post-test 2

Figure 3. Distribution of Total Correct on English Vocabulary Post-test 3
Figure 4. Distribution of Total Correct on English Vocabulary Post-test 4
Spanish Cognate Test.

The Spanish Cognate Test assessed the vocabulary knowledge of both taught and non-taught cognates. The mean total score of the Spanish Cognate Test was 22.03 points (SD 5.6) out of 38 possible points at data point 1. The mean total score at data point 2 was 20.71 points (SD 6.5). The mean total score at data point 3 was 21.24 points (SD 6.4). The mean total score at data point 4 was 22.53 points (SD 6.6). The reasonably bell-shaped histograms in the figures below suggest that the scores were normally distributed at all four data points. These descriptive results indicate two important points that may foreshadow trends for the individual growth models generated later. First, mean scores remained well below the maximum score of 38 points at all four data points, showing that the participating students continued to have plenty of room for improvement on average with regard to their Spanish cognate knowledge. Second, mean scores declined slightly from time 1 to time 2, then rose slightly from time 2 to time 3 and again from time 3 to time 4, such that mean scores at time 4 were comparable to those at time 1. The drop from time 1 to time 2 is not overly surprising, as time 1 occurred immediately following the intervention, and time 2 occurred after summer vacation. However, it is discouraging that by the end of 7th grade, mean scores were not appreciably higher than they had been a year earlier. This mean trend foreshadows a potential lack of significant growth in Spanish cognate knowledge.
Figure 5. Distribution of Total Correct on Spanish Cognate Post-test 1

Figure 6. Distribution of Total Correct on Spanish Cognate Post-test 2
Figure 7. Distribution of Total Correct on Spanish Cognate Post-test 3

Figure 8. Distribution of Total Correct on Spanish Cognate Post-test 4
Relationships Between English Vocabulary Test and Spanish Cognate Test.

Because this study is grounded in theories of cross-linguistic transfer, and as such, investigates potential cross-linguistic effects of Spanish cognate knowledge on English vocabulary knowledge and vice versa, it is important to begin with an investigation of correlations across English vocabulary and Spanish cognate scores at each data point. Since potentially varying patterns by ELLs or NON ELLs is another question of interest, it makes sense to generate these correlations separately for each subgroup. These descriptive results indicate two important points that may foreshadow trends for the individual growth models generated later. First, the scatter plots in figures 9, 10, 11 and 12 show that there are positive correlations for both subgroups at all four data points, and that the correlations for each subgroup appear to strengthen over time. The results are interesting because when taking into account the nature of the setting - a school where students are simultaneously learning two languages - the students are showing more evenness between the languages so they are not better at one than the
other. This evenness shows in the increase in correlation over time, particularly the ELLs.

Second, the scatter plots show that there are still students who are struggling in both languages at each data point. It is discouraging to see that by the end of 7th grade, some students continue to struggle in both assessments. These patterns may be consistent with the individual growth models generated later.

Figure 9. Correlation for English and Spanish EVoCA Post Test 1

Figure 10. Correlation for English and Spanish EVoCA Post Test 2
Figure 11. Correlation for English and Spanish EVoCA Post Test 2
The correlation matrix for each subgroup revealed the extent to which the relationship between the students’ skills on the two tests got stronger over time. For the ELLS (Table 7), there were significant, positive correlations across the two measures at all data points. ELLs were also the group for which the correlation was increasing the most. There was consistent growth from .63 at the 1st data point to .88 at data point 4. The NON ELLS (Table 8) likewise demonstrated significant, positive correlations at all four data points, but the correlations of this groups showed less of an increase. The correlation at time 1 was .66, increased markedly to .85 at time 2, and then held relatively steady through times 3 and 4, with a final correlation of .86 at time 4. All of the correlations were significantly larger than zero. As we can see in table 7 and table 8, the correlations increased overtime but we don’t know if each correlation was significantly bigger than the one before. The results show that the correlations were getting stronger but should not to be confused with the student’s skills. In other words, as is evident
from the scatter plots, there are many students with low scores in both English vocabulary and Spanish cognate knowledge.

Table 7

Correlation matrix for ELLs

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<th>English Post 3</th>
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** Correlation is significant at the 0.01 level

Table 8

Correlation matrix for NON ELLs
** Correlation is significant at the 0.01 level

The comprehension subtest of the Developmental Reading Assessment 2 (DRA2) was used as a universal pre-test of English literacy for all of the students. These scores were grand mean centered for more meaningful interpretation in the growth models. This assessment was designed to assess the oral reading fluency and comprehension of students. The mean total score of the DRA Comprehension test was 18.62 points (SD 1.6) out of a possible 24 points. The graphs in the figures below suggest that the scores were not normally distributed. It seems like a few students were outliers and then there is a slight positive skew to the rest of the distribution.

*Figure 13. DRA2 Comprehension*
EDL.
The comprehension subtest of the Evaluación del Desarrollo de la Lectura (EDL) was used as a universal pre-test of Spanish literacy for all of the students. These scores were grand mean centered to allow for more meaningful interpretation. The mean total score of the EDL Comprehension test at the sole time of administration (winter of 7th grade, corresponding to time 3 of the English vocabulary and Spanish cognate data collection) was 18.88 points (SD 2.4) out of a possible 24 points. The figure below suggests that the scores were not normally distributed. It seems like a few students were outliers and then there is a slight positive skew to the rest of the distribution.
STUDY 1 – English Vocabulary Knowledge

Average Trends in English Vocabulary Scores.

Table 9 presents mean English vocabulary scores at each data point for the sample overall, and by ELL status. Mean scores for the sample as a whole increased an average of 4.85 points between the end of sixth grade and the end of seventh grade. That increase was consistent across groups with scores of the NON ELLs increasing 5.13 points on average and the scores of the ELLs increasing 4.46 points on average across the four data points. There was a mean increase of .82 points for all students from the end of sixth grade until the beginning of seventh grade.
Looking further into the growth, the NON ELL group only grew by .44 points on average while the ELLs had the most growth with an increase of 1.31 points on average. The mean increase was 1.89 points (data point 2-3) for all students from the beginning of seventh grade through the middle of seventh grade. Looking further into the growth, the NON ELLs grew almost double the amount of ELLs (2.54 points on average) while the ELLs grew 1.02 points on average. The increase is most dramatic from the middle of seventh grade through the end of seventh grade (data point 3-4), when 2.14 total points in growth occur on average. This number was consistent for both the NON ELLs (2.15 points on average) and the ELLs (2.13 points on average). This phenomenon may be due, in part, to the developmental growth that occurs in students over time. As the students get older, their vocabulary increases and by the last data point, this may have been the case.

It is also interesting to notice that the standard deviations increased systematically from the end of sixth grade to the beginning of seventh grade (data point 1-2) indicating that the scores got further away from the mean and then decreased by the middle of seventh grade (data point 2-3) indicating that the scores got closer to the mean. Interestingly, the standard deviation of the NON ELLs continued to decrease through time 4 while the standard deviation of ELLs showed a slight increase implying that over time, the mean scores for the NON ELLs got closer to the mean and the mean scores for the ELLs got further away from the mean.

When comparing mean scores across subgroups at each data point, it can be seen that on the English test, the mean scores of the NON ELLs were approximately 10 points higher than the mean scores of ELLs at each data point. This is consistent with the achievement gap literature noted in Chapters 1 and 2; however, this study allows us to investigate potential ELL performance differentials within a primarily Latino subgroup, whereas other studies have
investigated Latino and ELL achievement gaps separately.

Table 9

Means and Standard Deviations for English Vocabulary Scores by ELL Status over Time

<table>
<thead>
<tr>
<th>Data Point</th>
<th>All Students</th>
<th>NON ELLs</th>
<th>ELLs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>23.77</td>
<td>28.06</td>
<td>19.38</td>
</tr>
<tr>
<td>1</td>
<td>(9.6)</td>
<td>(9.7)</td>
<td>(7.2)</td>
</tr>
<tr>
<td></td>
<td>(n=95)</td>
<td>(n=48)</td>
<td>(n=47)</td>
</tr>
<tr>
<td>2</td>
<td>24.59</td>
<td>28.50</td>
<td>20.69</td>
</tr>
<tr>
<td></td>
<td>(10.6)</td>
<td>(10.3)</td>
<td>(9.4)</td>
</tr>
<tr>
<td></td>
<td>(n=96)</td>
<td>(n=48)</td>
<td>(n=48)</td>
</tr>
<tr>
<td>3</td>
<td>26.48</td>
<td>31.04</td>
<td>21.71</td>
</tr>
<tr>
<td></td>
<td>(10.4)</td>
<td>(9.8)</td>
<td>(8.9)</td>
</tr>
<tr>
<td></td>
<td>(n=92)</td>
<td>(n=47)</td>
<td>(n=45)</td>
</tr>
<tr>
<td>4</td>
<td>28.62</td>
<td>33.19</td>
<td>23.84</td>
</tr>
<tr>
<td></td>
<td>(10.5)</td>
<td>(9.4)</td>
<td>(9.5)</td>
</tr>
<tr>
<td></td>
<td>(n=92)</td>
<td>(n=47)</td>
<td>(n=45)</td>
</tr>
</tbody>
</table>

In figure 15, the trajectory mean scores for NON ELLs are shown in the upper line and mean scores for ELLs are shown in the lower line, with the solid line “whiskers” extending +/- 1 standard deviation above and below the mean for each subgroup at each data point. These standard deviation “whiskers” demonstrate that there isn’t a considerable amount of overlap in the performance of the two groups. By the means not overlapping this graph shows that there are significant differences across the two subgroups at all data points, foreshadowing that there will
be significant differences in the English vocabulary intercept for ELLs vs. NON ELLs. Additionally, it looks like the mean increase in scores for both groups seems to be similar, foreshadowing that the rate of change may not vary by ELL status.

*Figure 15. Mean English Vocabulary Scores of NON ELLs and ELLs*

![Graph showing mean English vocabulary scores over months for NON ELLs and ELLs with error bars.

**Individual Empirical Growth Plots – English Vocabulary Test.**

Figure 16 presents individual empirical growth plots of the ELL students on the English Vocabulary test. It is interesting to note that there is a wide range of scores at all data points within the ELL subgroup, with some students evidencing high scores at all data points and others evidencing low scores at all data point. There are also students with very inconsistent scores meaning that there were some big jumps in growth between data points. Overall, some students
had scores that went down over the summer and some had scores that went up over the summer leaving the researcher with questions regarding the fluctuations such as: What types of words did the students lose over the summer?; Were they the taught words?; Were they non-taught words?; After the full year after the intervention took place, which words did the students retain? There is no way of answering these questions with the total number of scores, however, it is something to further explore for future research as will described in chapter 5.

*Figure 16. Empirical Growth Plots for ELLs on the English Vocabulary Test*

Figure 17 presents the growth trajectories of the NON ELL students on the English Vocabulary Test. The scores for the NON ELLs seem to have similar patterns seen with the ELLs. There seems to be a wide range of scores at all data points within the NON ELL subgroup, with some students evidencing high scores at all data points and others evidencing low scores at all data point. Additionally, there are still drastic changes in scores for some students between data points. Students show very inconsistent scores across data points, meaning that there were
some big jumps in growth between data points. Some of the students’ scores seem to drop after the summer while other spike after the summer leaving the researcher with similar questions as ELLs regarding the fluctuations of NON ELLs such as: What types of words did the students loose over the summer?; Were they the taught words?; Were they non-taught words?; After the full year after the intervention took place, which words did the students retain? There is no way of answering these questions with the total number of scores, however, it is something to further explore for future research as will described in chapter 5.

**Figure 17.** Empirical Growth Plots for NON ELLs on the English Vocabulary Test

**Creating a Hierarchical Linear Model.**

Having generated and reviewed descriptive statistics for the main variables of interest, I went on to construct a taxonomy of models to better understand the patterns of growth among Spanish English bilingual middle school students. At the first level (TIME), I examined the mean growth trajectory over the course of 12 months for all of the students (n=98). The analysis helped
to describe the shape of each person’s individual growth trajectory and to examine within person variability.

The analysis at the second level (STUDENTS) considered inter-individual differences in order to detect heterogeneity in change across individuals and to determine the relationship between predictors and the shape of each person’s individual’s growth trajectory. The independent variables for this level were non-time varying predictors; DRA, ELL, and INITSPAN. These were used to assess whether different people manifest differently across-individual change and to ask what predicts these differences. Non-time varying predictors that were dropped after deciding that there was no variability in the sample included native language (NL), free or reduced lunch eligibility (SES), and qualification for special education services (SPED). Only 10% were from homes were Spanish was not the main language, 9% of the students received Special education services, and 10% did not receive free/reduced lunch. These predictors were left out of the analyses due to the low variability.

Building a Taxonomy of Unconditional Models.

Research Question 1a: What are the initial status and the rate of change of English academic vocabulary development among Spanish-English bilingual students from the end of 6th grade to the end of 7th grade?
In order to check the initial status and the rate of change of English academic vocabulary, I first ran an unconditional model (Model 1) with no predictors shown below in Table 10. This model provided an average initial status for all students and an average rate of change for all students. According to this model the average student started the study with an English vocabulary score of 23.50 points (SD = 8.8) and grew about .41 points per month. This means that over the 12-month period, the average student gained close to 5 points on the English Vocabulary test, thereby leaving the students with a score of less than 29 points after a 12-month period. This growth was minimal considering that there were 53 items on this test.

The random effects provided information regarding whether the initial status and the rate of change were different for different students. The random effects output revealed that the variance for the intercept was statistically significant from 0, which allowed me to determine that there was variability across students with regard to initial status. In addition, the random effects output verified that the variance for the slope was not statistically significant from 0, which allowed me to determine that there was not variability in rate of change across students. In summary, the unconditional model showed that students entered into the study with varying levels of English vocabulary knowledge but that their growth in English vocabulary knowledge was similar. Furthermore, there was variability in the student’s initial status for English academic vocabulary development (p<.001) but the rate of change was similar among Spanish-English bilingual students from the end of 6th grade to the end of 7th grade (p=.235). Since all of the variability in the slope should be accounted for, the residual variance for the slopes can be eliminated, meaning that the residual variance for the effect is set equal to zero. When the residual for the slopes was removed from the unconditional model, the parameters were reduced because it eliminated the residual variance of the slopes and the residual covariance between the
slope and the intercept as parameters to be estimated (Raudenbush & Bryk, 2002).

The unconditional model was therefore run a second time without the residual slope as noted above (see table 11). This unconditional model (model 2) is the final model to respond to research question 1a. The initial status and rate of change in Model 2 are virtually identical to those for Model 1. Here, the average initial English vocabulary score was 23.48 points, and the average rate of change was again .41 points per month, meaning that on average, students gained close to 5 points over the course of the year, and this growth was statistically significant, although far short of the potential growth on this 53-item measure as shown in figure 18. The random effects again indicated that there was significant variation across students with regard to initial status, and as noted before, this model did not include random effects for the slope since they were found to be non-significant in Model 1. As the final unconditional model, Model 2 was the model used as the baseline model as student level predictors were added to create a taxonomy of conditional models in order to answer research question 1b.

Table 10

**STUDY 1 Unconditional Model 1**

**Final estimation of fixed effects:**

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td>23.498398</td>
<td>0.990063</td>
<td>23.734</td>
<td>91</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>0.406254</td>
<td>0.053688</td>
<td>7.567</td>
<td>91</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**Final estimation of variance components:**

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>8.81875</td>
<td>77.77041</td>
<td>90</td>
<td>647.41013</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MONTHS slope, $r_1$</td>
<td>0.15881</td>
<td>0.02522</td>
<td>90</td>
<td>99.32026</td>
<td>0.235</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>4.15075</td>
<td>17.22872</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

83
Table 11

**STUDY 1 Unconditional Model 2**

**Final estimation of fixed effects:**

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, ( \pi_0 )</td>
<td>( \beta_{00} )</td>
<td>23.483634</td>
<td>1.047054</td>
<td>22.428</td>
<td>91</td>
</tr>
<tr>
<td>For MONTHS slope, ( \pi_t )</td>
<td>INTRCPT2, ( \beta_{t0} )</td>
<td>0.409863</td>
<td>0.051802</td>
<td>7.912</td>
<td>252</td>
</tr>
</tbody>
</table>

**Final estimation of variance components:**

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>( \chi^2 )</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, ( r_0 )</td>
<td>9.38005</td>
<td>87.98533</td>
<td>91</td>
<td>1758.88282</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, ( e )</td>
<td>4.22875</td>
<td>17.88233</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 18.** Study 1 Final Unconditional Model

Building a Taxonomy of Conditional Models.

**Research Question 1b:** Controlling for English reading comprehension ability, do initial status and/or rate of English academic vocabulary development change vary according to ELL status and Spanish cognate knowledge?
Having generated an unconditional growth model to determine the average growth trend for all students, the next step was to fit a series of conditional growth models by adding a variety of student-level predictors into the model to determine the extent to which they helped to explain variation in English vocabulary scores across students. Before moving on to that step, however, it was useful to create a correlation matrix to look at relationships among key variables in a more exploratory way.

The correlation matrix for study 1 shows that there is a positive correlation between ELL and DRA; however, it is not statistically significant. There is a negative correlation between ELL and INITSPAN and it is statistically significant, showing that ELL students have significantly lower scores on the Spanish cognate test at time 1. This is a surprising finding, given that ELLs are likely to be more Spanish dominant. There is also a negative correlation between ELL and English vocabulary at data point 1 and it is statistically significant, meaning that ELL students tend to have lower time 1 English vocabulary scores than NON ELLs, which is not surprising. The correlation for DRA and INITSPAN is positive but not statistically significant. Similarly, there is positive but non-significant correlation between DRA and English vocabulary at data point 1; therefore, predicting that DRA will not be significant in my models.

The strongest correlation is between INITSPAN and English vocabulary time 1. This correlation is positive and it is statistically significant (.69**), meaning that students who score higher on the initial English vocabulary test will likewise score higher on the initial Spanish cognate test. This strong correlation allowed me to predict that INITSPAN will be a significant predictor in my models, thus lending support to the theoretical construct of cross-linguistic transfer.

Table 12

*Correlation Matrix for Study 1*
Moving ahead with the creation of the taxonomy of conditional growth models, I systematically investigated the effects of all of the variables on the intercept. The potential effects of the variables on the slope were not investigated because the unconditional models discussed earlier already determined that there was not significant variation across students with regard to rate of change. Table 14 presents the results generated by the conditional models as well as the unconditional models mentioned above, which were included for comparative purposes to gauge further improvement in fit and reduction in variance with the addition of student level predictors. Research question 1b will be answered in the discussion of the conditional models that follows.

Model 3 presents the model with DRA as a predictor of the intercept. DRA was not determined to be significantly related to initial status. The coefficient for the intercept was 23.48 (p<.001), meaning that the predicted initial English vocabulary test score for a student with a DRA score equal to the mean was 23.48 points and this was significantly different from 0. The effect of the DRA on initial English vocabulary test score was .10 points, meaning that for every 1 point increase on the DRA, there was an associated increase of .10 points on the initial English vocabulary score. This effect was shown to be positively but non-significantly associated with the intercept (p>.05). The slope coefficient was .41 (p<.001) confirming the earlier finding from the final unconditional model that there was significant growth of .41 points per month over the

** Correlation is significant at the 0.01 level
12 months of the study. The predicted English vocabulary test score for a student at the end of 7th grade with a DRA score at the mean is 28.4 \[23.48 + (.41*12)\]. In addition, as shown in Table 13, the fit statistics looks similar to model 2.

Next, I added ELL as a predictor of the intercept to the model and created Model 4. The coefficient for the intercept was 27.65 (p<.001), meaning that the predicted initial English vocabulary test score for a NON-ELL with a DRA score equal to the mean was 27.65 points and this was significantly different from 0. The effect of the DRA on predicted initial English vocabulary test score was .36 points, meaning that for every 1 point increase on the DRA, there was an associated increase of .36 points on the English vocabulary test score. While this was a noticeable increase in effect from Model 3, it was still not significantly associated with initial English vocabulary status (p=.51). The intercept differential for the students who were ELL was -8.52 points, meaning that the predicted initial English vocabulary scores of ELL students was 8.52 points lower on average than that of students who were not ELLs, controlling for DRA. The effect of the ELL status on predicted initial English vocabulary score was found to be significantly related to the intercept (p<.001). The slope coefficient was .41 (p<.001) confirming the earlier finding from the final unconditional model that there was significant growth of .41 points per month over the 12 months of the study. In this model, the predicted final English vocabulary score of ELL students with mean DRA scores was 24.05 points \[(27.65 – 8.52) + (.41*12)\] after 12 months, while the predicted English vocabulary score for NON ELLs with mean DRA scores at final status was 32.57 points \[27.65 + (.41*12)\]. Model 4 had a slightly reduced AIC statistic and a lower reduction in variance for the intercept indicating a slightly better fit.

Continuing with the model building process, I added the INITSPAN (initial Spanish
score) and took out ELL as a predictor creating Model 5. INITSPAN was needed in order to look at the influence across languages. In this model, INITSPAN showed how the initial status in Spanish affects English Vocabulary. The coefficient for the intercept was 23.47 (p<.001), meaning that the predicted initial English vocabulary score for a student who scored at the mean on the DRA and scored at the mean on the initial Spanish cognate test was 23.47 points and this was significantly different from 0. We find that INITSPAN was significantly related to the English vocabulary test (p=<.001), while DRA continued to not be significant (p=.629). For INITSPAN, the average estimated difference in initial English vocabulary scores was 1.28 points, meaning that there was 1.28 change in English vocabulary initial status score for every 1 point difference in initial Spanish cognate score, controlling for DRA. The slope coefficient was .40 (p<.001) confirming the earlier finding from the final unconditional model that there was significant growth of .40 points per month over the 12 months of the study. In this model, the predicted English vocabulary score at final status for students with mean DRA scores and mean initial Spanish cognate scores was 28.27 points [(23.47) + (.40*12)] after 12 months, controlling for DRA. Model 5 had a reduced AIC statistic and a lower reduction in variance for the intercept indicating a much better fit.

In Model 6, I added ELL back in as a predictor and took out DRA because up to this point, it had not been significantly associated with initial English vocabulary knowledge. In this model, the coefficient for the intercept was 25.63 (p<.001), meaning that the predicted initial English vocabulary score for a NON ELL with a mean score on the initial Spanish cognate test was 25.63 points and this was significantly different from 0. Notably, when these two variables were included in the model, they were both significantly associated with the outcome. The intercept differential for the students who were ELL was -4.40 points, meaning that the estimated English
vocabulary scores of ELL students was 4.40 points lower on average than that of students who were not ELLs, controlling for INITSPAN. While still significantly associated with the outcome, this is a considerable reduction in effect for ELL status from Model 4. For INITSPAN, the average estimated difference in initial English vocabulary scores was 1.16 points, meaning that there was 1.16 change in English vocabulary initial status score for every 1 point difference in initial Spanish cognate score. The slope coefficient was .4 (p<.001) confirming the earlier finding from the final unconditional model that there was significant growth of .40 points per month over the 12 months of the study. In this model, the predicted English vocabulary score at final status of ELL students was 26.03 points \[ (25.63 - 4.40) + (.40*12) \] after 12 months, while the predicted English score at final status for NON ELLs was 30.43 \[ 25.63 + (.40*12) \]. In addition the models tell us that Model 6 had the lowest reduced AIC statistic and a lower reduction in variance for the intercept, thus confirming that it was the model with the best fit. Figure 19 presents this final conditional model and shows the predicted English vocabulary development of NON ELLs with varying initial Spanish vocabulary scores.

*Figure 19. Study 1 Final Conditional Model*
The discussion above regarding the taxonomy of models provided me with the needed information to answer research question 1b. First, there was no value in controlling for English reading comprehension since it was never significantly associated with initial English vocabulary ability, as was foreshadowed by the non-significant correlation between the two variables. Second, both ELL status and initial Spanish cognate ability are significantly associated with initial English vocabulary knowledge. Finally, as determined by the taxonomy of unconditional models, there was no variation in the rate of change of English vocabulary across students.

Table 13
### Estimates of Fixed and Random Effects from Growth Models for English Vocabulary Development. Parameter estimates (standard errors); n=98, obs=392 (98 students * 4 waves of data)

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 1 (Unconditional 1)</th>
<th>Model 2 (Unconditional 2)</th>
<th>Model 3 (DRA)</th>
<th>Model 4 (DRA &amp; ELL)</th>
<th>Model 5 (DRA &amp; INITSPAN)</th>
<th>Model 6 (ELL &amp; INITSPAN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>23.49*** (.99)</td>
<td>23.48*** (1.04)</td>
<td>23.48*** (1.05)</td>
<td>27.65*** (1.31)</td>
<td>23.47*** (.72)</td>
<td>25.63*** (.94)</td>
</tr>
<tr>
<td>DRA on intercept</td>
<td>.10 (.61)</td>
<td>.36 (.55)</td>
<td>-.19 (.40)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELL on intercept</td>
<td>-8.52*** (1.83)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INITSPAN on Intercept</td>
<td>1.28*** (.11)</td>
<td>1.16*** (.11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slope (Months)</td>
<td>.41*** (.05)</td>
<td>.41*** (.05)</td>
<td>.41*** (.05)</td>
<td>.41*** (.05)</td>
<td>40*** (.05)</td>
<td>40*** (.05)</td>
</tr>
<tr>
<td>Student Level Random Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>17.22 (4.15)</td>
<td>17.88 (4.22)</td>
<td>17.88 (4.22)</td>
<td>17.87 (4.22)</td>
<td>18 (4.24)</td>
<td>17.97 (4.23)</td>
</tr>
<tr>
<td>Intercept</td>
<td>77.77*** (8.81)</td>
<td>87.98*** (9.38)</td>
<td>88.98*** (9.43)</td>
<td>71.60*** (8.46)</td>
<td>35.63*** (5.96)</td>
<td>31.34*** (5.59)</td>
</tr>
<tr>
<td>Months</td>
<td>0.02 (.15)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviance No. Parameters</td>
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<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Deviance</td>
<td>2309</td>
<td>2313</td>
<td>2313</td>
<td>2293</td>
<td>2238</td>
<td>2227</td>
</tr>
<tr>
<td>No. Parameters</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>6</td>
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</tr>
<tr>
<td>AIC</td>
<td>2321</td>
<td>2321</td>
<td>2323</td>
<td>2305</td>
<td>2250</td>
<td>2239</td>
</tr>
</tbody>
</table>

***P<.001, **P<.01, *P<.05

Fixed Effects and Variances are reported in Restricted Maximum Likelihood Deviance and Number of Parameters are reported from Full Maximum Likelihood

### STUDY 2 – Spanish Cognate Knowledge
**Average Trends in Spanish Cognate Vocabulary Scores.**

Table 14 presents mean Spanish cognate vocabulary scores at each data point for the sample overall and by ELL status. Mean scores for the sample as a whole increased slightly by an average of .5 points between the end of sixth grade and the end of seventh grade. The mean increase for NON ELLs was .26 points from data point 1 to data point 4, while the mean increase for ELLs was .69 points from data point 1 to data point 4. There was a mean decrease of -1.32 points for all students from the end of sixth grade until the beginning of seventh grade (data points 1-2). Examining the mean scores more closely revealed that the NON ELL group decreased by a mean of 1.05 points while the ELL had mean decrease of 1.5 points. There was a mean increase of .53 points (data points 2-3) for all students from the beginning of seventh grade through the middle of seventh grade. Looking further into the data the NON ELLs increased by a mean of 1.06 points while the ELLs continued to decrease by a mean of .02 points. There was an increase for all groups from the middle of seventh grade through the end of seventh grade (data points 3-4). The overall mean increase was 1.29 total points but this number was greater for the ELLs with a mean of 2.21 points than the NON ELLs with a mean of .25 points. Interestingly, the ELLs decreased during the first three data points but increased noticeably during the last wave of data. Finally, it is also interesting to notice that the standard deviations for the most part increased systematically from the end of sixth grade to the end of seventh grade (data points 1-4) indicating increasing variability of scores over time.

Comparing mean scores at each data point, the Spanish Cognate test showed that the NON ELLs had higher mean scores than the ELLs by approximately 3-5 points. The NON ELLs continued with trends of higher scores even on a test that is reflective of Spanish knowledge, where ELLs would be expected to have higher scores.
Table 14

*Means and Standard Deviations for Spanish Cognate Scores by ELL Status over Time*

<table>
<thead>
<tr>
<th>Data Point</th>
<th>All Students</th>
<th>NON ELLs</th>
<th>ELLs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22.03</td>
<td>23.67</td>
<td>20.33</td>
</tr>
<tr>
<td></td>
<td>(5.62)</td>
<td>(5.45)</td>
<td>(5.34)</td>
</tr>
<tr>
<td></td>
<td>(n=94)</td>
<td>(n=48)</td>
<td>(n=46)</td>
</tr>
<tr>
<td>2</td>
<td>20.71</td>
<td>22.62</td>
<td>18.83</td>
</tr>
<tr>
<td></td>
<td>(6.52)</td>
<td>(7.00)</td>
<td>(5.44)</td>
</tr>
<tr>
<td></td>
<td>(n=95)</td>
<td>(n=47)</td>
<td>(n=48)</td>
</tr>
<tr>
<td>3</td>
<td>21.24</td>
<td>23.68</td>
<td>18.81</td>
</tr>
<tr>
<td></td>
<td>6.49</td>
<td>(6.11)</td>
<td>(5.97)</td>
</tr>
<tr>
<td></td>
<td>(n=94)</td>
<td>(n=47)</td>
<td>(n=47)</td>
</tr>
<tr>
<td>4</td>
<td>22.53</td>
<td>23.93</td>
<td>21.02</td>
</tr>
<tr>
<td></td>
<td>(6.63)</td>
<td>(6.72)</td>
<td>(6.26)</td>
</tr>
<tr>
<td></td>
<td>(n=85)</td>
<td>(n=44)</td>
<td>(n=41)</td>
</tr>
</tbody>
</table>

In figure 20, the trajectory of mean scores for ELLs is the lower line and the trajectory of mean scores for the NON ELLs is the higher line, with the solid line “whiskers” extending +/- 1 standard deviation above and below the mean of each subgroup at each data point. These standard deviation “whiskers” demonstrate that there isn’t a considerable amount of overlap in the performance of the two groups until the last data point, where there is some partial overlap. The visual display with no overlap at time 1 foreshadows the likelihood that there will significant differences in the Spanish vocabulary intercept for ELLs vs. NON ELLs. Additionally, it looks like the mean increase in scores for both groups seems to be similar, foreshadowing that the rate of change may not vary by ELL status.

*Figure 20. Mean Spanish Cognate Scores of NON ELLs and ELLs*
Individual Empirical Growth Plots - Spanish Cognate Test.

Figure 21 presents individual empirical growth plots of ELL students on the Spanish Cognate test. It is interesting to note that there is a wide range of scores at all data points within the ELL subgroup, with some students evidencing high scores at all data points and others evidencing low scores at all data point. There are also students with very inconsistent scores meaning that there were some fluctuations in growth between data points. Overall, some students had scores that decreased over the summer and some had scores that increased over the summer leaving questions regarding the fluctuations such as: What types of words did the students lose over the summer?; Were they the taught words?; Were they non-taught words?; After the full year after the intervention took place, which words did the students retain? There is no way of answering these questions with the total scores used for this study; however, it is something to
consider for future research as will be discussed in chapter 5. Overall, from figure 21 it appears that there is great variability in Spanish Cognate scores among ELLs.

*Figure 21. Empirical Growth Plots for ELLs on the Spanish Cognate Test*

Figure 22 presents the growth trajectories of the NON ELLs on the Spanish Cognate test. As with the ELLs in Figure 19, the NON ELLS also appear to have a wide variability in scores at all data point. Some students showed greater fluctuations between data points while others showed more consistency. Overall, some students had scores that decreased over the summer and others had an increase of scores over the summer leaving similar questions as those posed in regard to Figure 19 such as: What types of words did the students lose over the summer?; Were they the taught words?; Were they non-taught words?; After the full year after the intervention took place, which words did the students retain? While it is not possible to answer these questions with the current data, it does open the door for future research.
Creating a Hierarchical Linear Model.

Having generated and reviewed descriptive statistics for the main variables of interest, I went on to construct a taxonomy of models to better understand the patterns of growth among Spanish English bilingual middle school students. At the first level (TIME), I examined the mean growth trajectory over the course of 12 months for all of the students (n=98). The analysis helped to describe the shape of each person’s individual growth trajectory and to examine within person variability.

The analysis at the second level (STUDENTS) considered inter-individual differences in order to detect heterogeneity in change across individuals and to determine the relationship between predictors and the shape of each person’s individual’s growth trajectory. The
independent variables for this level were non-time varying predictors; DRA, ELL, and INITSPAN. These were used to assess whether different people manifest differently across-individual change and to ask what predicts these differences. Non-time varying predictors that were dropped after deciding that there was no variability in the sample included native language (NL), free or reduced lunch eligibility (SES), and qualification for special education services (SPED). Only 10% were from homes where Spanish was not the main language, 9% of the students received Special education services, and 10% did not receive free/reduced lunch. These predictors were left out of the analyses due to the low variability.
Building a Taxonomy of Unconditional Models.

**Research Question 2a:** What are the initial status and the rate of change of Spanish cognate vocabulary among Spanish-English bilingual students from the end of 6th grade to the end of 7th grade?

In order to check the initial status and the rate of change of Spanish cognate vocabulary, I first ran (Model 1), an unconditional model with no predictors shown below in Table 15. This model provided an average initial status for all students and an average rate of change for all students. According to this model, the average student started the study with a Spanish cognate vocabulary score of 21.41 points (SD = 4.9) and grew about .01 points per month. This means that over the 12-month period, the average student gained close to .12 points on the Spanish cognate test, thereby leaving the students with a score of less than 21.53 points after a 12-month period. This growth was minimal considering that there were 38 items on this test.

The random effects provided information regarding whether the initial and the rate of change were different for different students. The random effects output revealed that the variance for the intercept is statistically significant from 0, which allowed me to determine that there was variability across students with regard to initial status. In addition, the random effects output verified that the variance for the slope was not statistically significant from 0, which allowed me to determine that there was not variability in rate of change across students.

In summary, the unconditional model showed that students entered into the study with varying levels of Spanish cognate knowledge but that their growth in Spanish cognate knowledge was similar. Furthermore, there was variability in the student’s initial status for Spanish cognate vocabulary development (p<.001) but the rate of change was similar among Spanish-English bilingual students from the end of 6th grade to the end of 7th grade (p=.335). Since all of the
variability in the slope should be accounted for, the residual variance for the slopes can be eliminated, meaning that the residual variance for the effect is set equal to zero. When the residual for the slopes was removed from the unconditional model, the parameters were reduced because it eliminated the residual variance of the slopes and the residual covariance between the slope and the intercept as parameters to be estimated (Raudenbush & Bryk, 2002).

The unconditional model was therefore run a second time without the residual slope as noted above (see table 16). This unconditional model (model 2) is the final model to respond to research question 2a. The initial status and rate of change in Model 2 are virtually identical to those for Model 1. Here, the average initial Spanish cognate vocabulary score was 21.39 points, and the average rate of change was again .02 points per month, meaning that on average, students gained close to .24 points over the course of the year, and this growth was not statistically significant (p=.65), and far short of the potential growth on this 38-item measure as shown in figure 23. Despite the lack of significant fixed effect for the slope, I decided to retain it in the model to keep the baseline models for study 1 and study 2 parallel; therefore, facilitating the comparison.

The random effects again indicated that there was significant variation across students with regard to initial status, and as noted before, this model did not include random effects for the slope since they were found to be non-significant in Model 1. As the final unconditional model, Model 2 was the model used as the baseline model as student level predictors were added to create a taxonomy of conditional models in order to answer research question 2b.
Table 15

STUDY 2 Unconditional Model 1

**Final estimation of fixed effects:**

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td>21.414946</td>
<td>0.578439</td>
<td>37.022</td>
<td>91</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>0.009505</td>
<td>0.038225</td>
<td>0.249</td>
<td>91</td>
<td>0.804</td>
</tr>
</tbody>
</table>

**Final estimation of variance components:**

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>4.97170</td>
<td>24.71780</td>
<td>90</td>
<td>446.82379</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MONTHS slope, $r_1$</td>
<td>0.13025</td>
<td>0.01697</td>
<td>90</td>
<td>95.14281</td>
<td>0.335</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>2.90213</td>
<td>8.42234</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 16

STUDY 2 Unconditional Model 2

**Final estimation of fixed effects:**

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td>21.394554</td>
<td>0.646996</td>
<td>33.068</td>
<td>91</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>0.016783</td>
<td>0.036471</td>
<td>0.460</td>
<td>252</td>
<td>0.646</td>
</tr>
</tbody>
</table>

**Final estimation of variance components:**

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>5.66799</td>
<td>32.12610</td>
<td>91</td>
<td>1316.44048</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>2.97829</td>
<td>8.87022</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 23. Study 2 Final Unconditional Model
Building a Taxonomy of Conditional Models.

Research Question 2b: Controlling for Spanish reading comprehension ability, do initial status and/or rate of change of Spanish cognate vocabulary vary according to ELL status and English vocabulary knowledge?

Having generated an unconditional growth model to determine the average growth trend for all students, the next step was to fit a series of conditional growth models by adding a variety of student-level predictors into the model to determine the extent to which they helped to explain variation in Spanish vocabulary scores across students. Before moving on to that step, however, it was useful to create a correlation matrix to look at relationships among key variables in a more exploratory way.

The correlation matrix for study 2 shows that there is a negative correlation between ELL and EDL and it is not statistically significant. The correlation between ELL and INITENG is negative and it is statistically significant; therefore, showing that ELL students score less on the INITENG and predicting that there will be collinearity. The same type of negative interaction occurs with Spanish Vocabulary at data point 1 and ELL, EDL and INITENG are positively correlated with no statistical significance; therefore, predicting that they will not be significant in the models. The correlation between EDL and Spanish vocabulary at time 1 is positive and statistically significant therefore predicting that these might be significant in my model. The strongest correlation is between INITENG and SPANISH vocab at time 1 (.74**), meaning that students who score higher on the initial Spanish vocabulary test will likewise score higher in the intital English vocabulary test. This strong correlation allowed me to predict that INITENG will be a significant predictor in my models, this lending support to the theoretical construct of cross-linguistic transfer.
Table 17

*Correlation Matrix for Study 2*

<table>
<thead>
<tr>
<th></th>
<th>ELL</th>
<th>EDL</th>
<th>INITENG</th>
<th>SPANISH VOCAB TIME 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELL</td>
<td>1</td>
<td>-.07</td>
<td>.45**</td>
<td>-.30**</td>
</tr>
<tr>
<td>EDL</td>
<td>-.07</td>
<td>1</td>
<td>.03</td>
<td>.15**</td>
</tr>
<tr>
<td>INITENG</td>
<td>-.45**</td>
<td>.03</td>
<td>1</td>
<td>.74**</td>
</tr>
<tr>
<td>SPANISH VOCAB TIME 1</td>
<td>-.30**</td>
<td>.15**</td>
<td>.74**</td>
<td>1</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level

Moving ahead with the creation of the taxonomy of conditional growth models, I systematically investigated the effects of all of the variables on the intercept. The potential effects of the variables on the slope were not investigated because the unconditional models discussed earlier already determined that there was not significant variation across students with regard to rate of change. Table 18 presents the results generated by the conditional models as well as the unconditional models mentioned above, which were included for comparative purposes to gauge further improvement in fit and reduction in variance with the addition of student level predictors. Research question 2b will be answered in the discussion of the conditional models that follows.

Model 3 presents the model with EDL as a predictor of the intercept. EDL was not determined to be significantly related to initial status. The coefficient for the intercept was 21.39 (p<.001), meaning that the predicted initial Spanish cognate score was 21.39 points and this was significantly different from 0. The effect of the EDL on the initial Spanish cognate score was .41 points, meaning that for every 1 point increase in the EDL, there was an associated increase of .41 points on the initial Spanish score. This effect was shown to be positive but non-significantly associated with the intercept (p=.04). The slope coefficient was .02
(p=.68) confirming that there was no significant growth over the 12 months of the study. The predicted Spanish cognate score for students at the end of 7th grade when DRA score at the mean is 21.63 [21.39 + (.02*12)]. In addition, as shown in Table 18, the fit statistics looks similar to model 2.

Next, I added ELL as a predictor of the intercept to the model and created Model 4. The coefficient for the intercept was 23.03 (p < .001), meaning that the predicted initial Spanish cognate score was 23.03 points and this was significantly different from 0. The effect of the EDL on predicted initial Spanish cognate score was .36 points, meaning that for every 1 point increase on the EDL, there was an associated increase of .36 points on the Spanish cognate score. The effect of the ELL status on predicted initial Spanish cognate score was found to be significantly related to the intercept, (p=.005). The EDL continued to not be related to the intercept (p=.134). The intercept differential for the students who were ELL was -3.3 points, meaning that the predicted initial Spanish Cognate scores of ELL students is 3.3 points lower on average than that of students who were not ELLs, controlling for EDL. The slope coefficient was .02 (p=.671) confirming the earlier finding from the final unconditional model that there was no significant growth over the 12 months of the study. In this model, the predicted Spanish cognate score of ELL students with mean EDL scores at final status was 19.97 points [(23.03 – 3.3) + (.02*12)] after 12 months, while the predicted Spanish cognate score for NON ELLs with mean EDL scores at final status was 23.27 points [23.03 + (.02*12)]. Model 4 had a slightly reduced AIC statistic and a lower reduction in variance for the intercept indicating a slightly better fit.

Continuing with the model building process, I added the INITENG (initial English score) and took out ELL as a predictor creating Model 5. INITENG was needed in order to look at the influence across languages. In this model, INITENG revealed how the initial status in English
affects Spanish cognate scores. The coefficient for the intercept was 21.40 (p<.001), meaning that the predicted initial Spanish cognate score was 21.40 points and this was significantly different from 0. We found that INITENG was significantly related to Spanish cognate and EDL was statistically significant for the first time in the model building process. For INITENG, the average estimated difference in initial Spanish cognate score was .50 points, meaning that there was a .50 increase in Spanish cognate initial status scores when controlling for EDL. The slope coefficient was .02 (p=.61) confirming that there was no significant growth over the 12 months of the study. In this model, the predicted Spanish cognate score for students with mean EDL scores and mean initial English vocabulary scores at final status was 21.64 points [(21.40) + (.02*12)] after 12 months, controlling for EDL. Model 5 had a reduced AIC statistic and a lower reduction in variance for the intercept indicating a much better fit.

In model 6, all of the variables were added into the model in order to further explore the effects. In model 5 the EDL became statistically significant for the first time so I left it in the model and added ELL, which was also statistically significant in model 4. I constructed this model that was inclusive of ELL, EDL and INITENG. The coefficient for the intercept was 21 (p<.001), meaning that the predicted initial Spanish cognate score was 21 points and this was significantly different from 0. Notably, EDL and INITENG are both statistically significant but ELL was no longer statistically significant. The intercept differential for the students who were ELL was positive at .81 points, meaning that the predicted Spanish cognate scores of ELL students was .81 points higher on average than that of students who were not ELLs, controlling for INITENG and EDL. The slope coefficient was .02 (p=.61) confirming that there was no significant growth over the 12 months of the study. In this model, the predicted Spanish cognate score at final status of ELL students was 22.05 points [(21.00 + .81) + (.02*12)] after 12 months,
while the predicted Spanish score at final status for NON ELLs was 21.24 \[21.00 + (.02*12)\] with no statistical significance.

For the sake of completeness, I decided to further investigate the reason why ELL was no longer significant. Continuing with the model building process, I added all three predictors; EDL, ELL, INITENG as well as an interaction term, ENGXELL and created Model 7. Interestingly, the EDL and INITENG were both statistically significant but ELL continued to not be significant. In addition, the interaction term ENGXELL was not statistically significant (see appendix C).

As final step, I checked the goodness of fit for the final conditional model in order to look for the best fit model. I looked for a model that had the lowest deviance. As I added predictors, there was a reduction in variance from model to model and it justified that model 5 was indeed the best fit model. Once the INITENG was added into model 5, ELL was no longer significant therefore confirming that once we controlled for INITENG, ELL no longer had an effect and was not an important predictor of Spanish vocabulary. In other words, the amount of English knowledge was a better predictor of Spanish vocabulary than whether the students were ELL or NON ELLs. In summary, the best fit model was model 5. Figure 24 presents this final conditional model and shows the predicted Spanish cognate development of NON ELLs with varying initial English vocabulary scores.
The discussion above regarding the taxonomy of models provided me with the needed information to answer research question 2b. First, when controlling for ELL status, there was a shift in the significance. In model 4, ELL was significant but once initial English vocabulary was added into the model, ELL stopped being significant. The correlation between these two variables was negative although significant (-.30) foreshadowing this shift. Second, both Spanish reading comprehension and initial English vocabulary ability were significantly associated with initial Spanish cognate vocabulary knowledge. Finally, as determined by the taxonomy of unconditional models, there was no variation in the rate of change of Spanish cognate vocabulary knowledge across students.
Table 18

*Estimates of Fixed and Random Effects from Growth Models for Spanish Vocabulary Development.* Parameter estimates (standard errors); n=98, obs=392 (98 students * 4 waves of data)

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 1 (Unconditional 1)</th>
<th>Model 2 (Unconditional 2)</th>
<th>Model 3 (EDL)</th>
<th>Model 4 (EDL &amp; ELL)</th>
<th>Model 5 (EDL &amp; INITENG)</th>
<th>Model 6 (EDL &amp; ELL &amp; INITENG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>21.41*** (.57)</td>
<td>21.39*** (.64)</td>
<td>21.39*** (.64)</td>
<td>23.03*** (.84)</td>
<td>21.40*** (.40)</td>
<td>21.00*** (.56)</td>
</tr>
<tr>
<td>EDL on intercept</td>
<td>.40 (.24)</td>
<td>.36 (.23)</td>
<td>.32* (.14)</td>
<td>.33* (.14)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELL on intercept</td>
<td>-3.34** (1.17)</td>
<td></td>
<td>.81 (.78)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INITENG on intercept</td>
<td></td>
<td></td>
<td>.50*** (.03)</td>
<td>.51*** (.04)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slope (Months)</td>
<td>.01 (.04)</td>
<td>.02 (.04)</td>
<td>.02 (.04)</td>
<td>.02 (.04)</td>
<td>.02 (.04)</td>
<td></td>
</tr>
</tbody>
</table>

| Student Level Random Effects |
|-----------------------------|-----------------|-----------------|-----------------|-------------------|-------------------|
| Residual                   | 8.42 (2.90)     | 8.87 (2.97)     | 8.86 (2.97)     | 8.86 (2.97)       | 8.90 (2.98)       | 8.90 (2.98)       |
| Intercept                  | 24.71*** (4.97) | 32.12*** (5.66) | 31.54*** (5.61) | 29.04*** (5.38)   | 9.03*** (3.00)    | 9.03*** (3.00)    |
| Months                     | .01 (.13)       |                 |                 |                   |                   |                  |

***P<.001, **P<.01, *P<.05

Fixed Effects and Variances are reported in Restricted Maximum Likelihood
Deviance and Number of Parameters are reported from Full Maximum Likelihood

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CHAPTER FIVE
DISCUSSION

Introduction

The purpose for this study was to investigate the vocabulary development of Spanish-English bilingual students in a dual language setting. This study was an observational study to look at the patterns of growth of these students post intervention. Vocabulary development is critically important for the improvement of overall literacy for both native English speakers and ELLs (August & Shanahan, 2006; Genesee et al., 2006; Goldenberg & Coleman, 2010; Graves, 2006; Proctor, August, Carlo & Barr, 2010). I was specifically interested in the English vocabulary development of students post intervention as well as Spanish vocabulary development post intervention. Furthermore, I wanted to explore cross-linguistic effects for each language and the relationships between the knowledge of vocabulary in one language and how it can influence vocabulary development in the other. To determine the growth of students over a twelve-month period, data were analyzed using descriptive statistics and Hierarchical Linear modeling (HLM) to investigate the growth in English and Spanish vocabulary post intervention.

In this chapter, the research questions for each study will be reviewed and the results will be discussed. The implications will follow, along with areas for further research. The limitations for this research will be addressed. Lastly, this chapter will conclude with a summary of the study.
Study 1

Research Question 1a

The research question focused on the initial status and the rate of change of English academic vocabulary among Spanish-English bilingual students. First, as noted in chapter 4, the coefficient for initial status was 23.5 points, meaning that the average English vocabulary score at the end of 6th grade was 23.5 points. This is a somewhat disappointing finding as the total possible score on the assessment was 53 points and the students had recently completed a vocabulary intervention that provided explicit instruction in one-third of the items on the test and cognate strategy instruction which would have ideally helped students to unlock the meaning of the additional non-taught cognate items on the test. The random effects from the unconditional model revealed that there was significant variation in initial status across students. The fact that there was variability in the students intercept was expected due to the diverse student population with different language proficiencies in both Spanish and English.

The slope coefficient in the final unconditional model was .41, meaning that on average, students’ English vocabulary scores increased significantly by .41 points per month. This means that during the 12-month period of the study, students gained approximately 5 points on the English vocabulary test on average. While significant, this growth is somewhat disappointing considering that there were 53 items on this test and there was therefore a lot more room for students to grow. Based on the average trends reported prior to the growth models, it appears that this limited growth was largely related to a summer drop-off effect, since mean scores fell considerably from the end of 6th grade through the end of 7th grade, and took the full 7th grade year to return to end-of-6th grade levels. This summer drop-off effect has been found in other studies, and indicates a need to find some way to stem this learning loss, such as through summer
enrichment programs (Wongkee, 2010). Additionally, the taxonomy of unconditional models revealed that there was no significant variation in the slope across students.

A study investigating different constructs by Mancilla et al., (2011) revealed that there was not significant variation in slopes across students in line with the results of this dissertation. Mancilla et al., (2011) investigated the English reading comprehension growth of middle school ELLs using a longitudinal design. Individual growth modeling revealed that both listening comprehension and word reading assessed in fifth grade predicted the elevation of students’ developmental trajectories in reading comprehension. However, neither skill predicted students’ growth in reading comprehension and there was no significant variation across students in growth rates, indicating that students in seventh grade remained on a trajectory established in fifth grade. Although different constructs were investigated the findings for the lack of variation in the slope across students were similar.

**Research Question 1b**

This research question focused on the effects of initial Spanish ability and ELL status controlling for English reading comprehension. Because the unconditional model revealed that there was no significant variance in growth across students, I looked at their potential impact on initial status. Having generated an unconditional growth model to determine the average growth trend for all students, the next step was to fit a series of conditional growth models by adding a variety of student-level predictors into the model to determine the extent to which they helped to explain variance in English vocabulary scores across students. I investigated the effects of English reading comprehension, ELL status and initial Spanish cognate knowledge on the English vocabulary intercept.
First, English reading comprehension was not found to be significantly associated with English vocabulary knowledge at Time 1. When DRA was added as a predictor in model 3, it had no affect on the English vocabulary scores. The correlations in chapter 4 revealed that there was a low correlation (.07) between DRA and English vocabulary at time 1. This information foreshadowed that English reading comprehension would not be a significant predictor in the model. Although reading comprehension and vocabulary have been researched, the line of research is more in line with Proctor et al., (2005) and Stahl & Fairbanks (1986) who looked at the relationships between English reading comprehension and English vocabulary knowledge and determined that vocabulary knowledge was identified as the most important indicator of comprehension for Spanish-English bilingual ELLs. These studies have found that vocabulary predicts comprehension; however, no studies have investigated the reverse of whether comprehension predicts vocabulary. In this dissertation, I included English reading comprehension as a global English literacy indicator because I did not have pre-test scores; however, there were no results suggesting the reading comprehension predicted vocabulary outcomes.

Next, ELL status was found to be significantly associated with English vocabulary knowledge. When ELL was added as a predictor in model 4, it had an effect on the English vocabulary scores. The correlations in chapter 4 revealed that there was a negative correlation between ELL and English vocabulary at time 1 but it was statistically significant (-.42). This information foreshadowed that ELL status would be a significant predictor in the model. Research such as Kieffer (2008) and Kieffer & Lesaux (2012) revealed that ELL scores lag behind NON ELLs scores. In fact, Kieffer (2008) investigated English reading comprehension among native English speakers and Spanish speaking ELLs from kindergarten through fifth
grade and found that growth slowed over time for both groups, but that the growth rate for ELLs slowed substantially more than the growth rate for native English speakers, yielding widening achievement gaps between the two groups. Kieffer & Lesaux (2012), did a study with 90 Spanish speaking ELLs in grades 4th-7th and revealed that ELLs demonstrated a positive and statistically significant growth in vocabulary knowledge and morphological awareness; however, despite this growth, the ELLs remained more than three-quarters of a standard deviation below national norms in vocabulary knowledge through seventh grade. Such results provide cause for concern regarding language development of ELLs. In this study, the consistent low levels of vocabulary knowledge in the early adolescence indicated that educators should attend to the vocabulary development of this population. Without the improvement of vocabulary, a majority of these learners will unlikely achieve language proficiency levels necessary to meet the academic demands of school and beyond. I had hoped that the results for this dissertation could have revealed that the intervention had helped Spanish-English bilinguals grow faster, but the intervention didn’t seem to have a differential effect for ELLs in terms of growth.

Lastly, Spanish cognate ability had a positive and significant association with English vocabulary knowledge. When Spanish cognate ability (INITSPAN) was added as a predictor in model 5, it had an effect on the English vocabulary scores. The correlations in chapter 4 revealed that there was a strong positive correlation (.69) between Spanish cognate ability and English vocabulary at time 1. This information foreshadowed that Spanish cognate ability would be a significant predictor in the model; therefore, confirming that there were some cross-linguistic relationships and that transfer may have resulted from the influence from similarities and differences between native language and a second language (Odlin, 1989). The results from the study by Durgunoglu, Nagy & Hancin-Bhatt (1993) mentioned in chapter 3 revealed that cross-
language transfer can occur and that Spanish-English bilingual children who had strong L1 decoding skills were similarly proficient at reading both words and non words in English. In addition, word recognition skills in Spanish were predictive of word recognition in English. Nakamoto et al., (2008) found that English reading comprehension was improved via the interaction of English decoding and Spanish vocabulary breadth therefore suggesting that Spanish vocabulary had an effect on English. In addition, when Proctor et al., (2005) compared Spanish language skills to English reading comprehension skills, he found that vocabulary knowledge was related to English reading comprehension. Although the Nakamoto et al., (2008) and Proctor et al., (2005) studies focused on reading comprehension and this dissertation focused on English vocabulary, they all still demonstrate a positive relationship between L1 and L2 literacy skills across languages.

Research Question 2a

The research question focused on the initial status and the rate of change of Spanish cognate vocabulary among Spanish-English bilingual students. First, as noted in chapter 4, the coefficient for initial status was 21.4 meaning that the average Spanish cognate score at the end of 6th grade was 21.4 points. This is a somewhat disappointing finding as the total possible score on the assessment was 38 points and the students had recently completed a vocabulary intervention that provided explicit instruction in one-third of the items on the test and cognate strategy instruction which would have ideally helped students to unlock the meaning of the additional Spanish cognate items on the test. The random effects from the unconditional model revealed that there was significant variation in initial status across students. The fact that there was variability in the students intercept was expected due to the diverse student population with different language proficiencies in both Spanish and English.
The slope coefficient in the final unconditional model was .02 with no statistical significance, meaning that on average, students’ English vocabulary scores increased by .01 points per month. This means that during the 12-month period of the study, students gained approximately .12 points on the English vocabulary test on average. This growth is very disappointing considering that there were 38 items on this test and there was therefore a lot more room for students to grow.

Given that the majority of the students were native Spanish speakers, and that fact that the intervention that took place was cognate related, different growth patterns were expected. In addition, because 50% of the sample was ELL and 89 out of 98 students were considered Native Spanish Speakers, meaning that we would expect them to have higher native language abilities and possibly being able to perform higher on the Spanish cognate test since it was in their native language. Research has investigated cognate relationships between vocabularies in L1 and L2 and there has been evidence of how Spanish-English bilinguals can draw on knowledge that is specific to the L1 when developing vocabularies in L2 (Jimenez, García and Person, 1996; Hancin-Bhatt & Nagy, 1994).

**Research Question 2b**

This research question focused on the effects of initial English ability and ELL status controlling for Spanish reading comprehension. Because the unconditional model revealed that there was no significant variance in growth across students, I looked at their potential impact on initial status. Having generated an unconditional growth model to determine the average growth trend for all students, the next step was to fit a series of conditional growth models by adding a variety of student-level predictors into the model to determine the extent to which they helped to explain variance in Spanish vocabulary scores across students.
First, Spanish reading comprehension was found to be significantly associated with Spanish cognate knowledge at Time 1. When EDL was added as a predictor in model 3, it had an effect on the Spanish cognate scores. The correlations in chapter 4 revealed that there was a positive correlation (.15) between EDL and Spanish cognate knowledge at time 1 and it was statistically significant. This information foreshadowed that Spanish reading comprehension would be a significant predictor in the model. This information is in line with Proctor et al., (2010) who looked at the relationships between Spanish reading comprehension and Spanish alphabetic knowledge and determined that Spanish alphabetic knowledge predicted Spanish reading comprehension for a group of 91 Spanish-English bilingual fourth grade student.

Next, ELL status was found to be significantly associated with English vocabulary knowledge until initial English was added into the model. When ELL was added as a predictor in model 4, it had an effect on the English vocabulary scores. The correlations in chapter 4 revealed that there was a negative correlation between ELL and Spanish vocabulary at time 1 but it was statistically significant (-.30). In addition, ELL and INITENG were negative correlated and it was statistically significant (-.45). INITENG and Spanish vocabulary at time 1 were strongly correlated (.74**). This information foreshadowed the dropping out of ELL because ELL and INITENG were significantly correlated with one another, and both were significantly correlated with the outcome of Spanish cognate ability; therefore, there was likely to be collinearity and the predictor with the stronger relationship (INITENG) was going to eliminate the predictor with the weaker relationship (ELL).

Research such as Kieffer & Lesaux (2012) shows that ELL scores lag behind NON ELLs. Again, such results provide cause for concern regarding language development of ELLs. In this study, the consistent low levels of vocabulary knowledge even in Spanish indicated that educators
should attend to the vocabulary development of this population. I had hoped that the results for
study 2 could have revealed that the intervention had helped Spanish-English bilinguals grow
faster, but the intervention didn’t seem to have a differential effect for ELLs in terms of growth.

Lastly, English vocabulary ability had a positive and significant association with Spanish
vocabulary knowledge. When English vocabulary ability (INITENG) was added as a predictor in
model 5, it had an effect on the Spanish vocabulary scores. The correlations in chapter 4 revealed
that there was a strong positive correlation (.74) between Spanish cognate ability and English
vocabulary at time 1. This information foreshadowed that Spanish cognate ability would be a
significant predictor in the model; therefore, confirming that there were some cross-linguistic
relationships and that transfer may have resulted from the influence from similarities and
differences between native language and a second language (Odlin, 1989). Similar to
Durgunoglu, Nagy and Hancin-Bhatt (1993); Meschyan and Hernandez (2002) worked with
college students who were native English speakers learning Spanish as an L2 and found a strong
relationship between L1 and L2 decoding and determined that L2 decoding skills were related to
other L2 outcomes such as vocabulary and reading comprehension. These studies have found
positive cross-linguistic associations between L1 and L2 within similar constructs.

Implications

The findings of the present study have implications for practitioners and policy makers
involved with meeting the needs of ELLs and in particular, Spanish-English bilinguals.
These implications fall in various areas. First, although the students were enrolled in an additive
bilingual model and the intervention was designed with the linguistic and cultural strengths and
needs of the ELLs in mind, the ELLs did not show the expected accelerated growth over NON
ELLs in study 1. In fact, their rate of growth in English vocabulary was similar to the NON
ELLs; and since they started at a lower level and did not grow faster, there was no closing of the achievement gap. These results highlight the need for continued exploration into better methods for supporting these students and closing the achievement gap in both national and state standardized assessments.

The findings of this dissertation were not surprising given that other studies have found similar results on the lack of accelerated growth. For example, Kieffer, (2008) in his longitudinal study of ELLs who began kindergarten with limited proficiency in English remained below their native English-speaking peers through fifth grade. The ELLs were not able to close achievement gap. In another study by Mancilla and Lesaux (2010) of Spanish speaking students in a longitudinal study that examined reading growth in students starting at age 4 to age 11 found the 11 year-olds reading at a second-grade level. While these students were primarily in English-only school environments, it confirms the current struggles of supporting ELLs to close the achievement gap.

Second, the Linguistic Interdependence Hypothesis, which posits that strong L1 language skills transfer to L2 language skills is supported by the findings of both study 1 and study 2. In study 1, controlling for English reading comprehension, students’ English vocabulary knowledge was predicted by their initial Spanish knowledge. In study 2, controlling for Spanish reading comprehension, students’ Spanish cognate knowledge was predicted by their initial English vocabulary knowledge. These findings are important in that they demonstrate the cross-language transfer and that language is not a uni-directional event. Nagy et al., (1993) found students’ English reading comprehension was mediated by first language vocabulary knowledge. This is similar to the current study in that it shows transfer of literacy skills in one language to literacy skills in another language. While Proctor et al., (2012) did not find a relationship between
English reading comprehension and Spanish knowledge with second, third, and fourth graders, Proctor et al., (2006) found that fourth grade bilingual students’ Spanish vocabulary breadth did have an effect on English reading comprehension. This study examined the predictive effect of Spanish cognate knowledge on English vocabulary rather than English reading comprehension. The results of this study indicate that Spanish cognate knowledge can predict English vocabulary knowledge.

Third, it was disappointing that there was no growth in the Spanish vocabulary knowledge of students given that the intervention was bilingual and the entire educational program of the school was bilingual. This finding indicates the need to continue examining ways to increase the quality of Spanish instruction within bilingual programs.

Finally, the low vocabulary scores in both the English Vocabulary test and the Spanish Cognate test implies that there is a clear need for concerted focus on explicit and sustained vocabulary instruction. Although the EVoCA intervention was inclusive of explicit instruction, it wasn’t sustained, both because it ended after 40 days, and because the 40-day sequence was highly interrupted by weather and testing. In particular, during the upper elementary and middle school grades, the students are expected to effectively learn from the texts in different content areas and they encounter more complex and unfamiliar content area vocabulary (Chall, 1987). In addition, the students also need to integrate vocabulary throughout the content areas in order to maximize the production of knowledge (Beck et al., 2002; Stahl & Nagy, 2006). For many ELLs, exposure to English may be limited to the regular school day, the explicit instruction of vocabulary is essential. Furthermore, the explicit instruction in word knowledge must be coupled with instruction to promote students’ word learning strategies (Graves, 2006; Mancilla-Martinez & Lesaux, 2010; Nagy & Scott, 2000). For Spanish-English bilinguals,
explicit instruction of cognates can be a promising avenue for the development of academic vocabulary ability. Jimenez et al. (1996) reported that bilingual students in Grades 6 and 7 who had a better awareness of the relationships between English and Spanish cognates used more successful strategies to infer word meaning, which in turn enabled them to comprehend texts better.

The participants in this study are reflective of the ELLs in the United States that are struggling to achieve academic success. The students in this study performed low on both the English Vocabulary test and the Spanish Cognate test. However, specific emphasis on explicit instruction and cognate awareness over a longer period of time and a more systematic approach across grade levels, could help improve the students vocabulary skills. More research needs to be done to examine exposure to and instruction of cognate words for Spanish-English bilingual middle school students.

**Areas for Further Research**

This study examined the vocabulary development of Spanish-English bilingual students from the end of 6th grade until the end of 7th grade. There are several areas in which the study could be extended. First, it would be helpful to look specifically at performance on taught cognates in English and taught cognates in Spanish, as well as non-taught cognates in each in both English and Spanish in order to see if the patterns of growth are similar or different when the assessments across languages are identical. In addition this would allow us to gain a better understanding on the effects of the intervention and further investigate what words the students learned and retained and what words the students learned and forgot and what words they learned over time. Second, this study investigated potential growth of Spanish-English bilingual students from the end of 6th grade to the end of 7th for a period of twelve months but future research could investigate the vocabulary development across grade levels and over a longer
period of time. Next, this study used EDL and DRA2 as baseline predictors of overall literacy in each language because only one of the homerooms was given the pre-test assessments. Originally, only one sixth grade class was going to received the intervention and then we realized that the teachers had taken it upon themselves to deliver the intervention to all four classes, therefore, there was never had a chance to pre-test the other 3 classes because we didn’t think they were going to be part of the study. Because the control variable in each study was not the most appropriate one, it would have been better to have had a pre-test and a global language proficiency measure in each language like that LAS links in order to have a more accurate comparison on outcome variables.

Lastly, it would be useful to conduct a future study with a different bilingual student population that is inclusive of more native English speakers. Although this was a dual language School with Spanish-English bilinguals, the majority of the students were native Spanish speakers. The findings could be useful as we could compare patterns and distinguish particular similarities and differences. These ideas could be additions to the research that would give the field more information about the vocabulary development of students.

**Limitations**

The major limitation of this study was the sample itself. This sample consisted of a single grade level (6th grade) from one school; therefore, not allowing for generalizability. In addition, this sample was homogeneous and that might have contributed to the lack of significant variability in the slope and as a result, a more heterogeneous sample in the future might create an interesting research study. In this study almost all of the students were native Spanish speakers, received free/reduced lunch, were not receiving special education services. In addition, all four
classes were in the same school and were even taught by the same teachers, and all students received the same intervention prior to this study. In order to find variability, we’d likely need more heterogeneity in student/context characteristics, different language profiles of kids, different schools and possibly different program models, different teachers, some kids who got the intervention and others who did not.

There are other limitations to this study. Because of nature of the school, the same teachers taught the students in the four classrooms; therefore, there was no opportunity to compare teacher effects. In addition, because the arrangements of classrooms were shifted several times due to lack of teachers, classroom variations could not be explored. Future research could study both the teacher effects and do a comparison of students within classrooms.

Furthermore, the inability to collect systematic pretest data on all students was a limitation. Data was collected after the intervention; however, in the future, pretesting of all students prior to the intervention would be beneficial in order to examine the effects of the intervention and the growth patterns of students.

Other limitations include threats to the internal validity such as test fatigue, testing exposure and attrition. In addition to the assessments listed in this dissertation, the larger EVoCA study administered more assessments (see appendix B for a complete list of assessments). Test fatigue was a legitimate possibility. These assessments, in addition to other assessments, such as the state assessments and school-wide benchmark assessments could have caused test fatigue. Testing exposure was another threat to the internal validity. The English Vocabulary test and the Spanish Cognate test that were given at each data point were identical; therefore, exposure to a test could have affected scores on subsequent exposures to that test. This occurrence could be confused with a long-term treatment effect. The tests were given with large intervals in between
them in order to reduce this threat. Lastly, attrition was a threat to the internal validity. Attrition refers the fact that some participants may fail to complete outcome variables. Due to the nature of the analysis that was used, (HLM), students were able to be retained in the study with as little as a single data point, therefore minimizing the threat of attrition. Additionally, the Spanish Cognate test and English Vocabulary test were not standardized; rather they were developed through field-test stage and a pilot stage, with substantial changes made based on those results. Psychometric analyses showed that there are strong reliability scores for these measures {English Vocabulary Test n= 53; Cronbach’s alpha = (.91); Spanish Cognate Test n=38; (Cronbach’s alpha = .78)} therefore, minimizing the limitation.

Finally, this study is focused on investigating the development of English vocabulary knowledge and Spanish cognate knowledge of Spanish-English bilingual adolescents in a dual language school. Because this study was embedded in a larger study and the students received a cognate-based intervention prior to collecting data for this dissertation, the findings will not be generalizable to other monolingual or bilingual students unless they are Spanish-English bilinguals in a similar setting and received the intervention. Therefore, we must accept this limitation.

Summary

The purpose of this study was to investigate the vocabulary development of Spanish-English bilingual adolescents in a dual language school. This study was observational in nature and examined the patterns of growth of these students post intervention. Through statistical methods we examined English vocabulary initial status and growth over time and Spanish cognate initial status and growth over time. The unconditional models for study 1 suggested that on average, students demonstrated significant growth in English vocabulary development from
the end of 6th grade to the end of 7th grade. There was significant variation across students with regard to initial status but not with regard to rate of change. The unconditional models for study 2 suggested that on average, students did not demonstrate significant growth in Spanish cognate knowledge from the end of 6th grade to the end of 7th grade. There was significant variation across students with regard to initial status but not with regard to rate of change. The conditional models for study 1 suggested that ELL status and initial Spanish cognate knowledge were significantly associated with initial English vocabulary knowledge while English reading comprehension (DRA) was not. The conditional models for study 2 suggested that while Spanish comprehension (EDL) and initial English significantly associated with initial Spanish cognate knowledge, the ELL status had no effect. These results suggest that these students need more explicit instruction in both Spanish and English in the area of vocabulary. Regardless of the initial status and growth, the scores of the students were significantly low on these two vocabulary outcomes in Spanish and English and this is an area that needs to be a focus for this group of Spanish-English bilingual adolescents.

Although further research in this area is certainly warranted, this study provides reasons to be optimistic about cross-linguistic relationships for Spanish-English bilingual students. This study was successful in providing information about the vocabulary development of this group on Spanish-English bilinguals. By providing students with a better understanding of vocabulary, and exploring cross-linguistic relationships, educators may begin to narrow the gaps in achievement for this student population.
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Appendix A

Key Terms

• bilingual - The term bilingual is used to refer to individuals with a language background other than the societal language who has developed proficiency in his or her primary language and some proficiency in the second language.

• cognates – Cognates are words in two (or more) languages that share a common root. They are similar not only in meaning, but also spelling, and/or pronunciation.

• development- The term development means a process of improving; growth.

• ELLs - English language learners or ELLs are students designated by public schools as students who cannot excel in an English language classroom. Designation procedures vary across states and school districts but often include a test of the student’s English reading and writing skills as well as listening and speaking abilities.

• L1- This refers to the language a person has learned from birth.

• L2- This refers to any language that a person learns after their first language.

• literacy - The term literacy refers to the ability to read, write and understand.

• reading – Reading refers to the cognitive process of understanding a written linguistic language.

• Spanish-English bilingual- The term Spanish-English bilingual refers to those who are learning both Spanish and English and have developed or are in the process of developing proficiency in both of the languages.

• transfer- The term transfer is used to describe cross-language relationships found in structures that belong exclusively to the linguistic domain (e.g., phonology), as well as skills that involve cognitive and language abilities (e.g., reading comprehension)
• **vocabulary** - *Vocabulary* refers to a set of words that are familiar within a language.
Appendix B

List of Assessments for the EVoCA Project

<table>
<thead>
<tr>
<th>Construct</th>
<th>Language</th>
<th>Assessment – Subtest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary (Reading)</td>
<td>English</td>
<td>Gates MacGinitie – Vocabulary</td>
</tr>
<tr>
<td></td>
<td>Spanish</td>
<td>WLPB-R – Reading Vocabulary</td>
</tr>
<tr>
<td></td>
<td>English</td>
<td>English EVoCA Vocabulary Test</td>
</tr>
<tr>
<td></td>
<td>Spanish</td>
<td>Spanish EVoCA Vocabulary Test</td>
</tr>
<tr>
<td>Reading Comprehension</td>
<td>English</td>
<td>Gates MacGinitie - Comprehension</td>
</tr>
<tr>
<td></td>
<td>Spanish</td>
<td>WLPB-R – Passage Comprehension</td>
</tr>
<tr>
<td>Reading Fluency/Decoding</td>
<td>English</td>
<td>TOSWRF (Test of Silent Word Reading Fluency)</td>
</tr>
<tr>
<td>Global Language Proficiency</td>
<td>English</td>
<td>TORC – Syntactic Similarities</td>
</tr>
<tr>
<td>Spelling</td>
<td>English</td>
<td>WTW Developmental Spelling Inventory</td>
</tr>
<tr>
<td>Morphology</td>
<td>English</td>
<td>Suffix Test and Roots Test</td>
</tr>
</tbody>
</table>
Appendix C

Study 2 - Model 7

Estimates of fixed and random effects from a series of growth models for Spanish vocabulary development. Parameter estimates (standard errors); n=98, obs=392 (98 students * 4 waves of data)

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>21.11*** (0.57)</td>
</tr>
<tr>
<td>EDL on intercept</td>
<td>0.36** (0.14)</td>
</tr>
<tr>
<td>ELL on intercept</td>
<td>0.91 (0.79)</td>
</tr>
<tr>
<td>INITENG on intercept</td>
<td>0.48*** (0.05)</td>
</tr>
<tr>
<td>ENGXELL (interaction term)</td>
<td>0.09 (0.08)</td>
</tr>
<tr>
<td>Slope (Months)</td>
<td>0.01 (0.03)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Student Level Random Effects</th>
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</thead>
<tbody>
<tr>
<td>Residual</td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>Months</td>
</tr>
<tr>
<td>Deviance</td>
</tr>
<tr>
<td>No. Parameters</td>
</tr>
</tbody>
</table>
AIC 1908

***P<.001, **P<.01, *P<.05

Fixed Effects and Variances are reported in Restricted Maximum Likelihood
Deviance and Number of Parameters are reported from Full Maximum Likelihood
Appendix D

HLM7 Outputs for STUDY 1- ENGLISH

Problem Title: Model 1- Unconditional

The maximum number of level-1 units = 345
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is ENGLISH

Summary of the model specified

**Level-1 Model**

\[ ENGLISH_{it} = \pi_{0i} + \pi_{1i} \times (MONTHS_{it}) + e_{it} \]

**Level-2 Model**

\[ \pi_{0i} = \beta_{00} + r_{0i} \]
\[ \pi_{1i} = \beta_{10} + r_{1i} \]

**Mixed Model**

\[ ENGLISH_{it} = \beta_{00} + \beta_{10} \times MONTHS_{it} + r_{0i} + r_{1i} \times MONTHS_{it} + e_{it} \]

**Final Results - Iteration 486**

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 17.22872 \]

\[ \tau \]

<table>
<thead>
<tr>
<th>INTRCPT1,( \pi_0 )</th>
<th>INTRCPT1,( \pi_0 )</th>
<th>MONTHS,( \pi_1 )</th>
<th>MONTHS,( \pi_1 )</th>
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<tbody>
<tr>
<td>77.77041</td>
<td>0.85322</td>
<td>85322</td>
<td>0.02522</td>
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</table>

\[ \tau \text{ (as correlations)} \]

<table>
<thead>
<tr>
<th>INTRCPT1,( \pi_0 )</th>
<th>INTRCPT1,( \pi_0 )</th>
<th>MONTHS,( \pi_1 )</th>
<th>MONTHS,( \pi_1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000</td>
<td>0.609</td>
<td>0.609</td>
<td>1.000</td>
</tr>
</tbody>
</table>

**Random level-1 coefficient**

| INTRCPT1,\( \pi_0 \) | 0.861 |
| MONTHS,\( \pi_1 \) | 0.096 |

Note: The reliability estimates reported above are based on only 91 of 92
units that had sufficient data for computation. Fixed effects and variance components are based on all the data. The value of the log-likelihood function at iteration 486 = -1.120087E+003

**Final estimation of fixed effects:**

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td>$\beta_{00}$</td>
<td>23.498398</td>
<td>0.990063</td>
<td>23.734</td>
<td>91</td>
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<tr>
<td>For INTRCPT2, $\pi_1$</td>
<td>$\beta_{10}$</td>
<td>0.406254</td>
<td>0.053688</td>
<td>7.567</td>
<td>91</td>
</tr>
</tbody>
</table>

**Final estimation of fixed effects (with robust standard errors)**

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td>$\beta_{00}$</td>
<td>23.498398</td>
<td>0.984228</td>
<td>23.875</td>
<td>91</td>
</tr>
<tr>
<td>For INTRCPT2, $\pi_1$</td>
<td>$\beta_{10}$</td>
<td>0.406254</td>
<td>0.053146</td>
<td>7.644</td>
<td>91</td>
</tr>
</tbody>
</table>

**Final estimation of variance components**

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>8.81875</td>
<td>77.77041</td>
<td>90</td>
<td>647.41013</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MONTHS slope, $r_1$</td>
<td>0.15881</td>
<td>0.02522</td>
<td>90</td>
<td>99.32026</td>
<td>0.235</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>4.15075</td>
<td>17.22872</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The chi-square statistics reported above are based on only 91 of 92 units that had sufficient data for computation. Fixed effects and variance components are based on all the data.

**Statistics for current covariance components model**

Deviance = 2240.173463
Number of estimated parameters = 4
Problem Title: Model 2 – Unconditional (removed the residual slope)

The maximum number of level-1 units = 345
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is ENGLISH

Summary of the model specified

Level-1 Model

\[ ENGLISH_{it} = \pi_{0i} + \pi_{1i} \times (MONTHS_{it}) + e_{it} \]

Level-2 Model

\[ \pi_{0i} = \beta_{00} + r_{0i} \]
\[ \pi_{1i} = \beta_{10} \]

Mixed Model

\[ ENGLISH_{it} = \beta_{00} + \beta_{10} \times MONTHS_{it} + r_{0i} + e_{it} \]

Final Results - Iteration 4

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 17.88233 \]

\[ \tau \]

INTRCPT1, \( \pi_0 \) 87.98533

Random level-1 coefficient Reliability estimate

| INTRCPT1, \( \pi_0 \) | 0.947 |

The value of the log-likelihood function at iteration 4 = -1.122091E+003

Final estimation of fixed effects:

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, ( \pi_0 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, ( \beta_{00} )</td>
<td>23.483634</td>
<td>1.047054</td>
<td>22.428</td>
<td>91</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>For MONTHS slope, ( \pi_1 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, ( \beta_{10} )</td>
<td>0.409863</td>
<td>0.051802</td>
<td>7.912</td>
<td>252</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Final estimation of fixed effects
(with robust standard errors)

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
</table>
For INTRCPT1, $\pi_0$
- INTRCPT2, $\beta_{00}$: 23.483634, 0.984124, 23.862, 91, <0.001

For MONTHS slope, $\pi_1$
- INTRCPT2, $\beta_{10}$: 0.409863, 0.053063, 7.724, 252, <0.001

<table>
<thead>
<tr>
<th>Final estimation of variance components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Effect</td>
</tr>
<tr>
<td>INTRCPT1, $r_0$</td>
</tr>
<tr>
<td>level-1, $e$</td>
</tr>
</tbody>
</table>

Statistics for current covariance components model
- Deviance = 2244.181503
- Number of estimated parameters = 2
Problem Title: Model 3- DRA as a predictor of the intercept

The maximum number of level-1 units = 345  
The maximum number of level-2 units = 92  
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is ENGLISH

Summary of the model specified

Level-1 Model

\[ ENGLISH_i = \pi_0 + \pi_1 (MONTHS_i) + e_i \]

Level-2 Model

\[ \pi_i = \beta_{00} + \beta_{01} (DRACOMP_i) + r_{0i} \]

\[ \pi_{ii} = \beta_{10} \]

DRACOMP has been centered around the grand mean.

Mixed Model

\[ ENGLISH_i = \beta_{00} + \beta_{01} (DRACOMP_i) + \beta_{10} (MONTHS_i) + r_{0i} + e_i \]

Final Results - Iteration 4

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 17.88246 \]

\[ \tau \]

\[ \text{INTRCPT1,}\pi_0 = 88.98701 \]

<table>
<thead>
<tr>
<th>Random level-1 coefficient</th>
<th>Reliability estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1,\pi_0</td>
<td>0.947</td>
</tr>
</tbody>
</table>

The value of the log-likelihood function at iteration 4 = -1.122567E+003

Final estimation of fixed effects:

| Fixed Effect | Coefficient | Standard | t-ratio | Approx. p-value |
|--------------|-------------|----------|---------|----------------|=|
### Final estimation of fixed effects (with robust standard errors)

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>23.483717</td>
<td>1.052242</td>
<td>22.318</td>
<td>90</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DRACOMP, $\beta_{01}$</td>
<td>0.102640</td>
<td>0.614292</td>
<td>0.167</td>
<td>90</td>
<td>0.868</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.409884</td>
<td>0.051803</td>
<td>7.912</td>
<td>252</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

### Final estimation of variance components

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>9.43329</td>
<td>88.98701</td>
<td>90</td>
<td>1757.50782</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>4.22877</td>
<td>17.88246</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Statistics for current covariance components model**

Deviance = 2245.133416  
Number of estimated parameters = 2
Problem Title: Model 4 DRA & ELL as predictors of the intercept

The maximum number of level-1 units = 345
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is ENGLISH

Summary of the model specified

Level-1 Model

ENGLISHᵢ = π₀ᵢ + π₁ᵢ * (MONTHSᵢ) + eᵢ

Level-2 Model

π₀ᵢ = β₀₀ + β₀₁ * (ELLᵢ) + β₀₂ * (DRACOMPᵢ) + r₀ᵢ
πᵢ = β₁₀

DRACOMP has been centered around the grand mean.

Mixed Model

ENGLISHᵢ = β₀₀ + β₀₁ * ELLᵢ + β₀₂ * DRACOMPᵢ
+ β₁₀ * MONTHSᵢ
+ rᵢ + eᵢ

Final Results - Iteration 4

Iterations stopped due to small change in likelihood function

σ² = 17.87010

τ
INTRCPT₁,π₀  71.60635

<table>
<thead>
<tr>
<th>Random level-1 coefficient</th>
<th>Reliability estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT₁,π₀</td>
<td>0.935</td>
</tr>
</tbody>
</table>

The value of the log-likelihood function at iteration 4 = -1.110326E+003

Final estimation of fixed effects:

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard</th>
<th>t-ratio</th>
<th>Approx. p-value</th>
</tr>
</thead>
</table>
### Final estimation of fixed effects (with robust standard errors)

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>27.657311</td>
<td>1.379782</td>
<td>20.045</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ELL, $\beta_{01}$</td>
<td>-8.526190</td>
<td>1.805661</td>
<td>-4.722</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DRACOMP, $\beta_{02}$</td>
<td>0.365986</td>
<td>0.549984</td>
<td>0.665</td>
<td>89</td>
<td>0.507</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.409668</td>
<td>0.053047</td>
<td>7.723</td>
<td>252</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

### Final estimation of variance components

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>8.46205</td>
<td>71.60635</td>
<td>89</td>
<td>1437.20653</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>4.22730</td>
<td>17.87010</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Statistics for current covariance components model

Deviance = 2220.652167  
Number of estimated parameters = 2
Problem Title: Model 5 – DRA & INIT SPAN (Removed ELL)

The data source for this run = C:\Users\NSOE-CTC\Desktop\Eileen Gonzalez\GD 3-29\Final EG.mdm
The command file for this run = C:\Users\NSOE-CTC\AppData\Local\Temp\whlmtemp.hlm
Output file name = C:\Users\NSOE-CTC\Desktop\Eileen Gonzalez\GD 3-29\hlm2.html
The maximum number of level-1 units = 345
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is ENGLISH

Summary of the model specified

Level-1 Model

\[ ENGLISH_i = \pi_{0i} + \pi_{1i}(MONTHS_i) + e_i \]

Level-2 Model

\[ \pi_{0i} = \beta_{00} + \beta_{01}(DRACOMP_i) + \beta_{02}(INITSPAN_i) + r_{0i} \]
\[ \pi_{1i} = \beta_{10} \]

DRACOMP INITSPAN have been centered around the grand mean.

Mixed Model

\[ ENGLISH_i = \beta_{00} + \beta_{01}DRACOMP_i + \beta_{02}INITSPAN_i \]
\[ + \beta_{10}MONTHS_i + r_{0i} + e_i \]

Final Results - Iteration 6

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 18.00291 \]

\[ \tau \]
INTRCPT1,\pi_0 35.63872

<table>
<thead>
<tr>
<th>Random level-1 coefficient</th>
<th>Reliability estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.63872</td>
<td></td>
</tr>
</tbody>
</table>

154
The value of the log-likelihood function at iteration 6 = -1.085473E+003

Final estimation of fixed effects:

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>23.473803</td>
<td>0.726728</td>
<td>32.301</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DRACOMP, $\beta_{01}$</td>
<td>-0.196021</td>
<td>0.404785</td>
<td>-0.484</td>
<td>89</td>
<td>0.629</td>
</tr>
<tr>
<td>INITSPAN, $\beta_{02}$</td>
<td>1.285464</td>
<td>0.118632</td>
<td>10.836</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.402475</td>
<td>0.051911</td>
<td>7.753</td>
<td>252</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Final estimation of fixed effects
(with robust standard errors)

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>23.473803</td>
<td>0.686714</td>
<td>34.183</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DRACOMP, $\beta_{01}$</td>
<td>-0.196021</td>
<td>0.367255</td>
<td>-0.534</td>
<td>89</td>
<td>0.595</td>
</tr>
<tr>
<td>INITSPAN, $\beta_{02}$</td>
<td>1.285464</td>
<td>0.108857</td>
<td>11.809</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.402475</td>
<td>0.053307</td>
<td>7.550</td>
<td>252</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Final estimation of variance components

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>5.96982</td>
<td>35.63872</td>
<td>89</td>
<td>728.89773</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>4.24298</td>
<td>18.00291</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statistics for current covariance components model

Deviance = 2170.945666
Number of estimated parameters = 2
Problem Title: Model 6 – ELL & INIT SPAN (REMOVED DRA)

The maximum number of level-1 units = 345
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is ENGLISH

Summary of the model specified

Level-1 Model

\[ ENGLISH_i = \pi_0 + \pi_1(MONTHS_i) + e_i \]

Level-2 Model

\[ \pi_0 = \beta_{00} + \beta_{01}(ELL_i) + \beta_{02}(INITSPAN_i) + r_{0i} \]
\[ \pi_i = \beta_{10} \]

INITSPAN has been centered around the grand mean.

Mixed Model

\[ ENGLISH_i = \beta_{00} + \beta_{01}(ELL_i) + \beta_{02}(INITSPAN_i) + \beta_{10}(MONTHS_i) + r_{0i} + e_i \]

Final Results - Iteration 6

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 17.97487 \]

\[ \tau \]

\[ \text{INTRCPT1,} \pi_0 \quad 31.34222 \]

<table>
<thead>
<tr>
<th>Random level-1 coefficient</th>
<th>Reliability estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1,\pi_0</td>
<td>0.864</td>
</tr>
</tbody>
</table>

The value of the log-likelihood function at iteration 6 = -1.079052E+003

Final estimation of fixed effects:

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard</th>
<th>t-ratio</th>
<th>Approx. p-value</th>
</tr>
</thead>
</table>
Final estimation of fixed effects (with robust standard errors)

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td>INTRCPT2, $\beta_{00}$</td>
<td>25.634191</td>
<td>0.948039</td>
<td>27.039</td>
<td>89</td>
</tr>
<tr>
<td>ELL, $\beta_{0l}$</td>
<td>-4.409647</td>
<td>1.318011</td>
<td>-3.346</td>
<td>89</td>
<td>0.001</td>
</tr>
<tr>
<td>INITSPAN, $\beta_{02}$</td>
<td>1.164022</td>
<td>0.117423</td>
<td>9.913</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.402242</td>
<td>0.051856</td>
<td>7.757</td>
<td>252</td>
</tr>
</tbody>
</table>

Final estimation of variance components

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>5.59841</td>
<td>31.34222</td>
<td>89</td>
<td>661.42988</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>4.23968</td>
<td>17.97487</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statistics for current covariance components model

Deviance = 2158.103610
Number of estimated parameters = 2
Appendix E

HLM7 Outputs for STUDY 2- SPANISH

Problem Title: The Unconditional Model 1

The maximum number of level-1 units = 345
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is SPANISH

Summary of the model specified

Level-1 Model

\[ SPANISH_{ii} = \pi_{0i} + \pi_{1i} \times (MONTHS_{ii}) + e_{ii} \]

Level-2 Model

\[ \pi_{0i} = \beta_{00} + r_{0i} \]
\[ \pi_{1i} = \beta_{10} + r_{1i} \]

Mixed Model

\[ SPANISH_{ii} = \beta_{00} + \beta_{10} \times MONTHS_{ii} + r_{0i} + r_{1i} \times MONTHS_{ii} + e_{ii} \]

Final Results - Iteration 1701

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 8.42234 \]

\[ \tau \]
\[ \text{INTRCPT1, } \pi_0 \quad 24.71780 \quad 0.63050 \]
\[ \text{MONTHS, } \pi_1 \quad 0.63050 \quad 0.01697 \]

\[ \tau \text{ (as correlations)} \]
\[ \text{INTRCPT1, } \pi_0 \quad 1.000 \quad 0.974 \]
\[ \text{MONTHS, } \pi_1 \quad 0.974 \quad 1.000 \]
### Random level-1 coefficient

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Reliability estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $\pi_0$</td>
<td>0.801</td>
</tr>
<tr>
<td>MONTHS, $\pi_1$</td>
<td>0.127</td>
</tr>
</tbody>
</table>

Note: The reliability estimates reported above are based on only 91 of 92 units that had sufficient data for computation. Fixed effects and variance components are based on all the data.

The value of the log-likelihood function at iteration 1701 = -9.830666E+002

### Final estimation of fixed effects:

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>$t$-ratio</th>
<th>Approx. d.f.</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td>21.414946</td>
<td>0.578439</td>
<td>37.022</td>
<td>91</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td>0.009505</td>
<td>0.038225</td>
<td>0.249</td>
<td>91</td>
<td>0.804</td>
</tr>
</tbody>
</table>

### Final estimation of fixed effects (with robust standard errors)

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>$t$-ratio</th>
<th>Approx. d.f.</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td>21.414946</td>
<td>0.571944</td>
<td>37.442</td>
<td>91</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td>0.009505</td>
<td>0.036614</td>
<td>0.260</td>
<td>91</td>
<td>0.796</td>
</tr>
</tbody>
</table>

### Final estimation of variance components

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>4.97170</td>
<td>24.71780</td>
<td>90</td>
<td>446.82379</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MONTHS slope, $r_1$</td>
<td>0.13025</td>
<td>0.01697</td>
<td>90</td>
<td>95.14281</td>
<td>0.335</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>2.90213</td>
<td>8.42234</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The chi-square statistics reported above are based on only 91 of 92 units that had sufficient data for computation. Fixed effects and variance components are based on all the data.

### Statistics for current covariance components model

Deviance = 1966.133185

Number of estimated parameters = 4
Problem Title: The Unconditional Model 2 (removed the residual for the slope)

The maximum number of level-1 units = 345
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is SPANISH

Summary of the model specified

Level-1 Model

\[ SPANISH_{it} = \pi_{0i} + \pi_{1i} \times (MONTHS_{it}) + e_{iti} \]

Level-2 Model

\[ \pi_{0i} = \beta_{00} + r_{0i} \]
\[ \pi_{1i} = \beta_{10} \]

Mixed Model

\[ SPANISH_{it} = \beta_{00} + \beta_{10} \times MONTHS_{it} + r_{0i} + e_{iti} \]

Final Results - Iteration 3

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 8.87022 \]

\[ \tau \]
INTRCPT1, \( \pi_0 \) 32.12610

<table>
<thead>
<tr>
<th>Random level-1 coefficient</th>
<th>Reliability estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, ( \pi_0 )</td>
<td>0.929</td>
</tr>
</tbody>
</table>

The value of the log-likelihood function at iteration 3 = -9.887681E+002

Final estimation of fixed effects:

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, ( \pi_0 )</td>
<td>( \pi_0 )</td>
<td>21.394554</td>
<td>0.646996</td>
<td>33.068</td>
<td>91</td>
</tr>
<tr>
<td>For MONTHS slope, ( \pi_1 )</td>
<td>( \pi_1 )</td>
<td>21.394554</td>
<td>0.646996</td>
<td>33.068</td>
<td>91</td>
</tr>
<tr>
<td>Fixed Effect</td>
<td>Coefficient</td>
<td>Standard error</td>
<td>t-ratio</td>
<td>Approx. d.f.</td>
<td>p-value</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------</td>
<td>----------------</td>
<td>---------</td>
<td>--------------</td>
<td>---------</td>
</tr>
<tr>
<td>For INTRCPT1, ( \pi_0 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, ( \beta_{10} )</td>
<td>21.394554</td>
<td>0.572728</td>
<td>37.356</td>
<td>91</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>For MONTHS slope, ( \pi_1 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, ( \beta_{11} )</td>
<td>0.016783</td>
<td>0.037011</td>
<td>0.453</td>
<td>252</td>
<td>0.651</td>
</tr>
</tbody>
</table>

Final estimation of variance components

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>( \chi^2 )</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, ( r_0 )</td>
<td>5.66799</td>
<td>32.12610</td>
<td>91</td>
<td>1316.44048</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, ( e )</td>
<td>2.97829</td>
<td>8.87022</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statistics for current covariance components model

Deviance = 1977.536119
Number of estimated parameters = 2
Problem Title: - Model 3 - EDL as a predictor of the intercept

The maximum number of level-1 units = 345
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is SPANISH

Summary of the model specified

Level-1 Model

SPANISH\(_i\) = \(\pi_0 + \pi_i \cdot \text{MONTHS}_i + e_i\)

Level-2 Model

\[ \begin{align*}
\pi_0 &= \beta_{00} + \beta_{01} \cdot \text{EDLCOMP}_i + r_0 \\
\pi_i &= \beta_{10}
\end{align*} \]

EDLCOMP has been centered around the grand mean.

Mixed Model

SPANISH\(_i\) = \(\beta_{00} + \beta_{01} \cdot \text{EDLCOMP}_i + \beta_{10} \cdot \text{MONTHS}_i + r_0 + e_i\)

Final Results - Iteration 3

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 8.86448 \]

\[ \tau \]

INTRCPT1,\(\pi_0\) 31.54543

<table>
<thead>
<tr>
<th>Random level-1 coefficient</th>
<th>Reliability estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1,(\pi_0)</td>
<td>0.928</td>
</tr>
</tbody>
</table>

The value of the log-likelihood function at iteration 3 = -9.888100E+002

Final estimation of fixed effects:

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Effect</td>
<td>Coefficient</td>
<td>Standard error</td>
<td>t-ratio</td>
<td>Approx. d.f.</td>
<td>p-value</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
<td>----------------</td>
<td>---------</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td>INTRCPT2, $\beta_{00}$</td>
<td>21.393123</td>
<td>0.642071</td>
<td>33.319</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>EDLCOMP, $\beta_{01}$</td>
<td>0.409015</td>
<td>0.248157</td>
<td>1.648</td>
<td>90</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_i$</td>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.015401</td>
<td>0.036468</td>
<td>0.422</td>
<td>252</td>
</tr>
</tbody>
</table>

**Final estimation of fixed effects**

(With robust standard errors)

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td>INTRCPT2, $\beta_{00}$</td>
<td>21.393123</td>
<td>0.568048</td>
<td>37.661</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>EDLCOMP, $\beta_{01}$</td>
<td>0.409015</td>
<td>0.193382</td>
<td>2.115</td>
<td>90</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_i$</td>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.015401</td>
<td>0.037028</td>
<td>0.416</td>
<td>252</td>
</tr>
</tbody>
</table>

**Final estimation of variance components**

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>5.61653</td>
<td>31.54543</td>
<td>90</td>
<td>1292.22062</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>2.97733</td>
<td>8.86448</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Statistics for current covariance components model**

Deviance = 1977.620000
Number of estimated parameters = 2

163
Problem Title: Model 4 –EDL & ELL as predictors of the intercept

The maximum number of level-1 units = 345
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is SPANISH

Summary of the model specified

Level-1 Model

\[ SPANISH_i = \pi_{0i} + \pi_{1i}(MONTHS_i) + e_{ti} \]

Level-2 Model

\[ \pi_{0i} = \beta_{00} + \beta_{01}(ELL_i) + \beta_{02}(EDLCOMP_i) + r_{0i} \]
\[ \pi_{1i} = \beta_{10} \]

EDLCOMP has been centered around the grand mean.

Mixed Model

\[ SPANISH_i = \beta_{00} + \beta_{01}ELL_i + \beta_{02}EDLCOMP_i + \beta_{10}MONTHS_i + r_{0i} + e_{ti} \]

Final Results - Iteration 4

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 8.86486 \]

\[ \tau \]
INTRCPT1.\( \pi_0 \) 29.04045

<table>
<thead>
<tr>
<th>Random level-1 coefficient</th>
<th>Reliability estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1.( \pi_0 )</td>
<td>0.922</td>
</tr>
</tbody>
</table>

The value of the log-likelihood function at iteration 4 = -9.828708E+002

Final estimation of fixed effects:
<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>23.033949</td>
<td>0.845709</td>
<td>27.236</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ELL, $\beta_{01}$</td>
<td>-3.349454</td>
<td>1.172980</td>
<td>-2.856</td>
<td>89</td>
<td>0.005</td>
</tr>
<tr>
<td>EDLCOMP, $\beta_{02}$</td>
<td>0.362622</td>
<td>0.239631</td>
<td>1.513</td>
<td>89</td>
<td>0.134</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.015522</td>
<td>0.036465</td>
<td>0.426</td>
<td>252</td>
<td>0.671</td>
</tr>
</tbody>
</table>

**Final estimation of fixed effects**
*(with robust standard errors)*

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>23.033949</td>
<td>0.822991</td>
<td>27.988</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ELL, $\beta_{01}$</td>
<td>-3.349454</td>
<td>1.149702</td>
<td>-2.913</td>
<td>89</td>
<td>0.005</td>
</tr>
<tr>
<td>EDLCOMP, $\beta_{02}$</td>
<td>0.362622</td>
<td>0.182228</td>
<td>1.990</td>
<td>89</td>
<td>0.050</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.015522</td>
<td>0.037044</td>
<td>0.419</td>
<td>252</td>
<td>0.676</td>
</tr>
</tbody>
</table>

**Final estimation of variance components**

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>5.38892</td>
<td>29.04045</td>
<td>89</td>
<td>1188.10363</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>2.97739</td>
<td>8.86486</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Statistics for current covariance components model**

Deviance = 1965.741665
Number of estimated parameters = 2
Problem Title: Model 5 - EDL & INIT ENG / Removed ELL

The maximum number of level-1 units = 345
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is SPANISH

Summary of the model specified

Level-1 Model

\[ SPANISH_i = \pi_{0i} + \pi_{1i}(MONTHS_i) + e_{yi} \]

Level-2 Model

\[
\begin{align*}
\pi_{0i} &= \beta_{00i} + \beta_{01i}(EDLCOMP_i) + \beta_{02i}(INITENG_i) + r_{0i} \\
\pi_{1i} &= \beta_{10i} \\
\end{align*}
\]

EDLCOMP INITENG have been centered around the grand mean.

Mixed Model

\[
SPANISH_i = \beta_{00i} + \beta_{01i}(EDLCOMP_i) + \beta_{02i}(INITENG_i) + \beta_{10i}(MONTHS_i) + r_{0i} + e_{yi}
\]

Final Results - Iteration 6

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 8.90546 \]

\[ \tau \]

INTRCPT1,π0 9.03706

<table>
<thead>
<tr>
<th>Random level-1 coefficient</th>
<th>Reliability estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1,π0</td>
<td>0.788</td>
</tr>
</tbody>
</table>

The value of the log-likelihood function at iteration 6 = -9.414941E+002

Final estimation of fixed effects:
<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>21.404714</td>
<td>0.409639</td>
<td>52.253</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>EDLCOMP, $\beta_{01}$</td>
<td>0.321478</td>
<td>0.147620</td>
<td>2.178</td>
<td>89</td>
<td>0.032</td>
</tr>
<tr>
<td>INITENG, $\beta_{02}$</td>
<td>0.500849</td>
<td>0.037709</td>
<td>13.282</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.019015</td>
<td>0.036471</td>
<td>0.521</td>
<td>252</td>
<td>0.603</td>
</tr>
</tbody>
</table>

**Final estimation of fixed effects**
(with robust standard errors)

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>21.404714</td>
<td>0.372599</td>
<td>57.447</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>EDLCOMP, $\beta_{01}$</td>
<td>0.321478</td>
<td>0.148101</td>
<td>2.171</td>
<td>89</td>
<td>0.033</td>
</tr>
<tr>
<td>INITENG, $\beta_{02}$</td>
<td>0.500849</td>
<td>0.030909</td>
<td>16.204</td>
<td>89</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.019015</td>
<td>0.037087</td>
<td>0.513</td>
<td>252</td>
<td>0.609</td>
</tr>
</tbody>
</table>

**Final estimation of variance components**

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>3.00617</td>
<td>9.03706</td>
<td>89</td>
<td>428.66858</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>2.98420</td>
<td>8.90546</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Statistics for current covariance components model**

Deviance = 1882.988170
Number of estimated parameters = 2
Problem Title: Model 6 – Study 2 ELL & INITENG & EDL

The data source for this run = C:\Users\NSOE-CTC\Desktop\Eileen Gonzalez\GD 3-29\Final EG.mdm
The command file for this run = C:\Users\NSOE-CTC\AppData\Local\Temp\whlmtemp.hlm
Output file name = C:\Users\NSOE-CTC\Desktop\Eileen Gonzalez\GD 3-29\hlm2.html
The maximum number of level-1 units = 345
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is SPANISH

Summary of the model specified

Level-1 Model

\[ SPANISH_i = \pi_{0i} + \pi_{1i} \times (MONTHS_i) + e_i \]

Level-2 Model

\[ \pi_{0i} = \beta_{00} + \beta_{01} \times (ELL_i) + \beta_{02} \times (EDLCOMP_i) + \beta_{03} \times (INITENG_i) + r_{0i} \]
\[ \pi_{1i} = \beta_{10} \]

EDLCOMP INITENG have been centered around the grand mean.

Mixed Model

\[ SPANISH_i = \beta_{00} + \beta_{01} \times ELL_i + \beta_{02} \times EDLCOMP_i + \beta_{03} \times INITENG_i + \beta_{10} \times MONTHS_i + r_{0i} + e_i \]

Final Results - Iteration 6

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 8.90322 \]

\[ \tau \]
\[ INTRCPT1.\pi_0 \quad 9.03639 \]

<table>
<thead>
<tr>
<th>Random level-1 coefficient</th>
<th>Reliability estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1.\pi_0</td>
<td>0.788</td>
</tr>
</tbody>
</table>
The value of the log-likelihood function at iteration 6 = -9.412015E+002

**Final estimation of fixed effects:**

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>21.006772</td>
<td>0.561516</td>
<td>37.411</td>
<td>88</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ELL, $\beta_{01}$</td>
<td>0.811615</td>
<td>0.783356</td>
<td>1.036</td>
<td>88</td>
<td>0.303</td>
</tr>
<tr>
<td>EDLCOMP, $\beta_{02}$</td>
<td>0.331761</td>
<td>0.147944</td>
<td>2.242</td>
<td>88</td>
<td>0.027</td>
</tr>
<tr>
<td>INITENG, $\beta_{03}$</td>
<td>0.519272</td>
<td>0.041690</td>
<td>12.456</td>
<td>88</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.019084</td>
<td>0.036466</td>
<td>0.523</td>
<td>252</td>
<td>0.601</td>
</tr>
</tbody>
</table>

**Final estimation of fixed effects**
**(with robust standard errors)**

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{00}$</td>
<td>21.006772</td>
<td>0.581733</td>
<td>36.111</td>
<td>88</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ELL, $\beta_{01}$</td>
<td>0.811615</td>
<td>0.807078</td>
<td>1.006</td>
<td>88</td>
<td>0.317</td>
</tr>
<tr>
<td>EDLCOMP, $\beta_{02}$</td>
<td>0.331761</td>
<td>0.147103</td>
<td>2.255</td>
<td>88</td>
<td>0.027</td>
</tr>
<tr>
<td>INITENG, $\beta_{03}$</td>
<td>0.519272</td>
<td>0.035670</td>
<td>14.558</td>
<td>88</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>For MONTHS slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT2, $\beta_{10}$</td>
<td>0.019084</td>
<td>0.037063</td>
<td>0.515</td>
<td>252</td>
<td>0.607</td>
</tr>
</tbody>
</table>

**Final estimation of variance components**

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>3.00606</td>
<td>9.03639</td>
<td>88</td>
<td>423.63922</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>2.98383</td>
<td>8.90322</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Statistics for current covariance components model**

Deviance = 1882.403064
Number of estimated parameters = 2
Problem Title: Model 7 with ELL, EDL INITENG and Interaction term (ENGXELL)

The data source for this run = C:\Users\NSOE-CTC\Desktop\Eileen Gonzalez\GD 3-29\Interactions 4-5-13mdmt.mdm
The command file for this run = C:\Users\NSOE-CTC\AppData\Local\Temp\whlmttemp.hlm
Output file name = C:\Users\NSOE-CTC\Desktop\Eileen Gonzalez\GD 3-29\hlm2.html
The maximum number of level-1 units = 368
The maximum number of level-2 units = 92
The maximum number of iterations = 100

Method of estimation: restricted maximum likelihood

The outcome variable is SPANISH

Summary of the model specified

Level-1 Model

\[ SPANISH_{ij} = \beta_{0j} + \beta_{1j} \times (MONTHS_{ij}) + r_{ij} \]

Level-2 Model

\[ \beta_{0j} = \gamma_{00} + \gamma_{01} \times (ELL_j) + \gamma_{02} \times (EDLCOMP_j) + \gamma_{03} \times (INITENG_j) + \gamma_{04} \times (ENGXELL_j) + u_{0j} \]
\[ \beta_{1j} = \gamma_{10} \]

EDLCOMP INITENG have been centered around the grand mean.

Mixed Model

\[ SPANISH_{ij} = \gamma_{00} + \gamma_{01} \times (ELL_j) + \gamma_{02} \times (EDLCOMP_j) + \gamma_{03} \times (INITENG_j) + \gamma_{04} \times (ENGXELL_j) + \gamma_{10} \times (MONTHS_{ij}) + u_{0j} + r_{ij} \]

Run-time deletion has reduced the number of level-1 records to 349

Final Results - Iteration 6

Iterations stopped due to small change in likelihood function

\[ \sigma^2 = 8.92299 \]

\[ \tau \]

INTRCPT1.\beta_0 \quad 9.18696
Random level-1 coefficient Reliability estimate

| INTRCPT1, $\beta_0$ | 0.793 |

The value of the log-likelihood function at iteration 6 = -9.527963E+002

Final estimation of fixed effects:

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\beta_0$</td>
<td>21.115999</td>
<td>0.578489</td>
<td>36.502</td>
<td>87</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>INTRCPT2, $\gamma_{00}$</td>
<td>0.914903</td>
<td>0.794990</td>
<td>1.151</td>
<td>87</td>
<td>0.253</td>
</tr>
<tr>
<td>ELL, $\gamma_{01}$</td>
<td>0.362686</td>
<td>0.146112</td>
<td>2.482</td>
<td>87</td>
<td>0.015</td>
</tr>
<tr>
<td>EDLCOMP, $\gamma_{02}$</td>
<td>0.483249</td>
<td>0.052427</td>
<td>9.218</td>
<td>87</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>INITENG, $\gamma_{03}$</td>
<td>0.095286</td>
<td>0.087437</td>
<td>1.090</td>
<td>87</td>
<td>0.279</td>
</tr>
</tbody>
</table>

For MONTHS slope, $\beta_1$

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT2, $\gamma_{10}$</td>
<td>0.017734</td>
<td>0.036463</td>
<td>0.486</td>
<td>275</td>
<td>0.627</td>
</tr>
</tbody>
</table>

Final estimation of fixed effects (with robust standard errors)

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\beta_0$</td>
<td>21.115999</td>
<td>0.604454</td>
<td>34.934</td>
<td>87</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>INTRCPT2, $\gamma_{00}$</td>
<td>0.914903</td>
<td>0.783167</td>
<td>1.168</td>
<td>87</td>
<td>0.246</td>
</tr>
<tr>
<td>ELL, $\gamma_{01}$</td>
<td>0.362686</td>
<td>0.157654</td>
<td>2.301</td>
<td>87</td>
<td>0.024</td>
</tr>
<tr>
<td>EDLCOMP, $\gamma_{02}$</td>
<td>0.483249</td>
<td>0.048379</td>
<td>9.989</td>
<td>87</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>INITENG, $\gamma_{03}$</td>
<td>0.095286</td>
<td>0.069039</td>
<td>1.380</td>
<td>87</td>
<td>0.171</td>
</tr>
</tbody>
</table>

For MONTHS slope, $\beta_1$

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>Approx. d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT2, $\gamma_{10}$</td>
<td>0.017734</td>
<td>0.036799</td>
<td>0.482</td>
<td>275</td>
<td>0.630</td>
</tr>
</tbody>
</table>

Final estimation of variance components

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Standard Deviation</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $u_0$</td>
<td>3.03100</td>
<td>9.18696</td>
<td>87</td>
<td>425.15682</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>level-1, $r$</td>
<td>2.98714</td>
<td>8.92299</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statistics for current covariance components model

Deviance = 1905.592644
Number of estimated parameters = 2