GROWTH TRAJECTORIES OF LITERACY SKILLS FOR EAL CHILDREN FROM SECOND THROUGH SEVENTH GRADES

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

The Faculty of Graduate Studies

(School Psychology)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

April 2013

ABSTRACT

There is ongoing debate among researchers and educators regarding the utility of English L1 practices for English-as-an-Additional-Language (EAL) learners who are in need of special education services. The identification of reading disability for EAL children is often delayed because relatively little is known about how EAL learners develop to be competent readers. This study sought to address this by providing descriptions of how children grow in their literacy skills and what predicts successful acquisition of these skills. This longitudinal study followed 773 L1 and 182 EAL children from grades 2 through 7. Multi-group latent growth analyses provided compelling evidence for common developmental models for L1 and EAL in word recognition, word reading fluency, decoding, decoding fluency, reading comprehension, and spelling. Phonological processing, syntactic awareness, and verbal working memory were important predictors of growth for children from both language groups. Growth models also show that poor readers from both language groups continued to be behind normally achieving peers. For poor readers, growth in word recognition, word reading fluency, decoding, decoding fluency, and reading comprehension was characterized by a persistent deficit model. In contrast, there was a cumulative deficit for spelling. That is, poor readers started out with poor spelling skills and progressed at a slower rate than normally achieving readers, thus widening the gap over time. Poor readers, as a group, also demonstrated weaknesses across phonological processing, syntactic awareness, and verbal working memory. Overall, the results of this study highlight the importance of early services and assessment for all children at risk for reading disability, regardless of first language status.

PREFACE

The author conducted the data analyses and the writing for this dissertation. The author also participated in the program coordination and data collection for a two year portion of the longitudinal project. Dr. Siegel designed and supervised the research program. Ethics approval for this research project was granted by the University of British Columbia's Behavioural Research and Ethics Board (UBC-BREB), certificate number B96-0509.

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ACKNOWLEDGEMENTS

First and foremost, I wish to thank the teachers, district personnel, and administrators in the North Vancouver School District who made it possible for us to work with the students in their school district.

I have also had the good fortune of being surrounded by many talented and passionate mentors throughout my graduate studies. I owe a lifetime of gratitude to my supervisor, Dr. Linda Siegel, who has taught me to think more deeply and to question status quo. I am also fortunate to have Dr. Laurie Ford as my committee member and program advisor who has helped me through the ups and downs, especially in this final stretch. Also thank you to Dr. Bruno Zumbo, committee member, for igniting in me a passion for statistics and research methodology that I never knew existed.

Thank you to all the students in the school psychology program with whom I have shared laughter, tales of woe, and dreams of what is still to come. Also thank you to alumni lab members Nonie Lesaux, Orly Lipka, and Jill Etmanskie for their leadership at various points in this study.

Most of all, I could not speak enough of my wonderful family whose patience, love, and support made it possible for me to complete this journey. Thus, it is fitting that I concluded this acknowledgement and this final stroke of words with my deepest appreciation for my husband, Peter Lee, with whom I will be closing this chapter in my life and embarking on a new life learning journey.

CHAPTER 1: INTRODUCTION

Study Relevance

The economy of British Columbia is in transition from one that is primarily resource-based to one that is knowledge-based. In a knowledge-based economy, human capital is heavily measured by levels of literacy and education. Thus illiteracy is a formidable public concern. In 2011, the Office of the Premier renewed its efforts to "make BC the best-educated, most literate jurisdiction on the continent" and continued to place literacy at the top of the province's *Five Great Goals* (Government of BC, 2011). However, the province is faced with the challenges of meeting the needs of an increasingly diverse student population. This is largely due to the influx of immigration to BC in the recent decades, accounting for over 75% of the population growth between 1996 and 2001 (Statistics Canada, 2001). In Canada one out of every five children is learning English-as-an-Additional-Language (EAL), and in Vancouver one out of every three children is EAL (Statistics Canada, 2006). The current school-aged EAL population in Vancouver is approximately 30%, and an estimated 33,555 EAL children entered the school system between the period of 2006 and 2010 (Statistics Canada, 2006). For school systems this translates into an increasing number of children who enter school with minimal formal instruction in English and who are immersed into English classrooms. Not surprisingly, considerable attention is being directed towards the acquisition of English literacy skills for EAL children and the benefits of the mainstream school curriculum in helping them achieve readiness to learn.

School systems are struggling to understand the types of curricula to appropriately serve the needs of the general EAL population. Furthermore, schools are also struggling to determine whether current assessment practices, such as those related to high-stakes testing, can be fairly applied to EAL children. Unfortunately, the provision of services for EAL children with reading disability has been impeded by misunderstandings and beliefs surrounding oral language proficiency. In fact, EAL children are referred for assessment anywhere from three to five years later than native English L1 speaking children (Limbos & Geva, 2001; Wagner, Francis, & Morris, 2005). Consequently, EAL children may be inadvertently denied remediation at the most crucial stages of literacy development (i.e., the years with the greatest potential for growth). The traditional belief is that EAL reading difficulties arise from inadequate oral language proficiency in the English language. Hence, reading tests are biased representations of EAL children's reading skills. However, there is growing evidence to suggest that the importance of oral language proficiency is somewhat less compelling than initially believed (Geva, 2000; Limbos & Geva, 2001).

An accumulating body of evidence suggests that oral language proficiency is not a reliable predictor of whether EAL children will or will not have difficulty with word recognition (the basis for diagnosing a reading disability). For instance, in a longitudinal study of first-grade EAL children, phonological awareness and rapid naming were found to be significant predictors of word recognition at six months and one year later (Geva, Yaghoub-Zadeh, & Schuster, 2000). Oral language proficiency (as measured by vocabulary) and nonverbal intelligence were not found to be significant predictors at either time periods. Furthermore, research has shown that oral language proficiency is a strong predictor in reading comprehension but not in single word reading (Durgunoglu, Nagy, & Hancin-Bhatt, 1993; Geva & Siegel, 2000). If the same level of oral language proficiency is not required for word reading as it is for reading comprehension, then word recognition measures can be useful in assessing the reading skills of EAL learners. Yet, the identification of EAL children who are in need of special education remains an area of great contention.

The lack of research examining models of EAL reading development has been one of the major challenges to the early identification of reading problems in EAL children (for reviews see Cline, 2000; Durkin, 2000; McCardle, Mele-McCarthy, & Leos, 2005). Without this information teachers remain reluctant to initiate educational referrals even if EAL children are clearly struggling (Limbos & Geva, 2001). This places EAL children at an increased risk not only for school failure but also a variety of devastating yet preventable secondary outcomes, such as delinquency, social-emotional disruption, and even suicidal ideation (Barwick & Siegel, 1996; Casey, Levy, Brown, & Brooks-Gunn, 1992; McBride & Siegel, 1997; Svetaz, Ireland, & Blum, 2001; Willcutt & Pennington, 2000). Thus, it is imperative to know whether the same pattern of literacy development is shared across children from diverse language backgrounds and reading abilities. The best way to understand this is through a prospective longitudinal study. Unfortunately, there is a paucity of longitudinal studies looking at the growth of EAL literacy through the elementary years. In fact, there is only one published study examining reading growth in EAL children past the primary grades (e.g., Lesaux, Rupp, & Siegel, 2007). Furthermore, most studies have focused on a singular aspect of literacy, such as word recognition, decoding, reading comprehension, or spelling. A developmental picture of comparative literacy skills is yet to be revealed.

Overview of the Study

The general aim of this study was to investigate the development of various literacy skills in English L1 and EAL children. Evidence shows that there may be more similarities than differences between L1 and EAL in terms of the component skills that contribute to reading success. However, there is a lack of available longitudinal research on the comparability of L1 and EAL developmental models. This study is a unique contribution to the body of literature in its efforts to describe the development of word recognition, word reading fluency, decoding, decoding fluency, reading comprehension, and spelling through the middle childhood years (second to seventh grade). Of interest was the existence or nonexistence of common developmental patterns for English L1 and EAL children, with and without reading difficulties. Of additional interest was whether English cognitive-linguistic skills were equal predictors of literacy growth for L1 and EAL children. Finally, the relationship between reading and spelling development was examined.

Research Questions

This study was guided by the following four research questions:

(1) Are there common developmental models for L1 and EAL children?

Hypotheses: Growth for L1 and EAL children on all measures of literacy will be characterized by common developmental models. However, the shape of growth for each literacy skill may vary.

(2) How well do cognitive-linguistic skills at grade 2 predict initial levels and rates of change?

Hypothesis: Phonological processing, syntactic awareness, and verbal working memory will be significant predictors on initial skill level and in the rates of change for all literacy skills.

(3) Are there group differences related to reader status (Normally Achieving or Poor Readers) in the growth trajectories of literacy skills?

Hypotheses: There will be a significant reader group difference at initial status and in the rates of change. There will continue to be a difference even when cognitive-linguistic skills are accounted for.

(4) To what extent does the growth in spelling parallel the growth in word recognition?

Hypotheses: There will be a significant relationship between word recognition and spelling, specifically where children start and how they grow. Stronger word recognition skills will be associated with stronger spelling skills.

CHAPTER 2: LITERATURE REVIEW

This chapter summarizes the different processes involved in reading, highlighting what is known about EAL children with good and poor reading skills. The literature review establishes the empirical foundation on which the rationale of the study is situated. This chapter begins with an overview of a reading model, called the Simple View of Reading, and how this model makes the distinction between word recognition, oral language, and reading comprehension. The importance of this model, in relation to the current research, is for its utility in shedding some light on the current debate surrounding oral language proficiency and the assessment of reading disability in EAL children. Following the Simple View of Reading is a description of reading disability and how impairment in phonological and orthographic routes can lead to reading difficulties for L1 and EAL children. The notion of cross-linguistic transfer of skills will then be introduced with a specific focus on phonological processing, syntactic awareness, and verbal working memory as prominent predictors in the development of literacy skills across languages. Finally, the chapter concludes with the existing literature on developmental models of reading for EAL children, thus forming the final context for understanding the particular need for the current research study.

Reading and Reading Disability

Simple View of Reading

Reading is a multifaceted construct. In the literature, the term "reading" is often broadly defined. For instance, the term has been used for decoding, word recognition, and reading comprehension. In their model of the Simple View of Reading, Gough and Tunmer (1986) proposed that reading comprehension is the product of two skills: context-free word recognition and language comprehension (Hoover & Gough, 1990). A measure of language comprehension (i.e., oral language) assesses the ability to understand language, whereas a measure of reading comprehension assesses the same skill but where the process begins with print. According to this model, it is possible to separate groups of readers based on reading comprehension and word recognition skills. For instance, Lesaux, Lipka, and Siegel (2006) found that children who had poor reading comprehension in addition to poor word recognition could be dissociated from children who had poor reading comprehension only. In children with poor reading comprehension only, the impairments were related to the language comprehension process and not the word reading process.

The separation of word recognition from oral language makes the Simple View of Reading particularly interesting for EAL research given the controversy surrounding oral language proficiency and reading assessment. A number of studies have applied the Simple View of Reading to EAL reading (e.g., Gottardo & Mueller, 2009; Kang, Choi, Lee, & Nam, 2011) and to reading in other orthographies (e.g., Chinese and Spanish - Joshi, Tao, Aaron, & Quiroz, 2012; Dutch - Verhoeven & Leeuwe, 2012). As predicted from the Simple View of Reading, it is possible to have good word recognition skills in spite of weak oral language proficiency. This has been shown for EAL children attending primary grades (Geva, Yaghoub-Zadeh, & Schuster, 2000) and intermediate grades (Low & Siegel, 2005). On the other hand, oral language can still interfere with reading comprehension despite good word recognition. Low and Siegel (2005) found in a group of sixth-grade children that there was a L1 advantage on a standardized measure of reading comprehension despite comparable word recognition skills for L1 and EAL children. This L1 advantage in reading comprehension was also accompanied by stronger L1 oral language proficiency, as measured by oral cloze. The dissociation between word recognition and reading was also demonstrated by Verhoeven's (1990) study of bilingual Turkish-Dutch children. Even after 20 months of instruction, Turkish-Dutch children were weaker than native Dutch speaking children on reading comprehension despite similarly developed word recognition skills. Verhoeven attributed this to the mediating effects of oral language proficiency.

The results of such studies suggest that oral language proficiency can affect EAL reading comprehension via top-down processes such as syntactic awareness, even if bottom-up processes such as phonological processing, decoding, and word recognition are comparably developed to L1 learners. So if the identification of a reading disability was contingent on a skill directly impacted by oral language proficiency, as is reading comprehension, then the argument for delaying EAL assessment would be persuasive. However, the prevailing view is that word recognition is central to the whole reading process and that inaccurate and/or dysfluent word recognition forms the basis for a reading disability. Given that oral language proficiency does not undermine EAL children's ability to develop word recognition skills, measures of word recognition can be a valid way of assessing reading disability in EAL children. Still, oral language proficiency cannot be ignored. Reading comprehension and related oral language skills, such as syntactic awareness, should also be assessed to determine whether there are general comprehension issues.

Reading Disability

Reading disability is defined in this research as a specific impairment in the accuracy and/or fluency of the word recognition process. Reading disability does not result from a general developmental disability and persists despite adequate opportunity to acquire reading skills. The terms dyslexia and specific reading disability have also been used to refer to the same phenomenon. The prevalence of reading disability has been estimated to range from 5% in clinical samples to 17% in unselected population based samples (Shaywitz & Shaywitz, 2003). Reading fits a dimensional model, meaning that good and poor reading occur along a continuum with reading disability representing the lower tail of the distribution (Shaywitz &

Shaywitz, 2005). Measures of word recognition (reading aloud single words) and decoding (reading aloud pseudowords) are frequently used as the major criterion in the assessment of reading disability. However, there is not always a consensus on what cut-off points are to be used. In practice, some psychologists use the 25^{th} percentile as a cut-off point to define an area of academic difficulty whereas others use the 16^{th} percentile. The 25^{th} percentile is often used in research as it has been found to separate good and poor readers on a variety of tasks, and it also matches teachers' and parents' perceptions of when children struggle at school (Siegel, 2003). Although Stanovich (1999) advises that any cut-off value is essentially subjective, he recommends a more stringent cut-off with the use of the 15^{th} percentile on either word recognition or decoding. Difficulties also emerge on tests that are highly related to decoding/word recognition, such as reading comprehension, spelling, and writing. Most, if not all, children with reading disability have underlying cognitive processing weaknesses that interfere with general learning. For instance, most children with reading disability have difficulties in the areas of phonological processing, working memory, and syntactic knowledge (Siegel, 1993). As such, functional areas secondary to reading are also impacted, such as mathematics, planning, organization, language, and sometimes social skills.

While there have been various approaches to defining a reading disability, the historical view is that there is "unexpected" reading failure. That is, reading achievement is unexpected given an individual's aptitude as estimated by an IQ score on an intelligence test. Problems with this discrepancy definition have been extensively highlighted by researchers (e.g., Siegel, 1992; Stanovich, 2005). Since the argument over the discrepancy formula is not the focus of this research, the history is very briefly reviewed here. It has been argued that children with reading disability and other poor readers do not differ in terms of the basic processes underlying reading, such as phonological processing (for a review see Siegel, 1992). Furthermore, individuals with a reading disability tend to perform more poorly on certain areas of IQ tests due to cumulative effects of underlying cognitive processing weaknesses. Thus, their particular functioning is difficult to be estimated from a summarized global IQ score thereby making it difficult to show an IQ-achievement discrepancy. Another argument is that there is undifferentiated reading intervention for children with problems in reading, regardless of whether an IQ-achievement discrepancy is present. In 2007, the National Association of School Psychologists (NASP) stated that "relying primarily upon an ability discrepancy as the means of identifying children with specific learning disabilities is at odds with scientific research and with best practice" (p. 1). Around the same time, the BC Association of School Psychologists (BCASP) summarized the same problem in their Best Practices report (BCASP, 2007). BCASP reviewed the psychometric issues with the current way of identifying/diagnosing a learning disability, highlighting the problematic use of "average" intelligence. However, they did not provide a position statement but simply conclude that IQ testing is controversial in the assessment of learning disabilities.

Orthographic versus Phonological Routes to Reading

Although it is generally agreed that skilled early readers will sound out words when reading, this is not the only way to learn to read. One well known model of reading is the Dual Route Cascaded model (for a review see Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). Simply put, the dual-route model posits that there are two general routes to word recognition: a lexical (i.e., orthographic) route and a non-lexical (i.e., phonological) route. Impairment in either the lexical (orthographic) or non-lexical (phonological) route can lead to difficulties in learning to read. Reading via the orthographic route involves recognizing the visual features of the word and then retrieving the word from memory. This is commonly referred to as "sight word reading." Coltheart further proposes that there are actually two orthographic sub-routes:

lexical semantic and lexical non-semantic. The difference between the two lexical sub-routes is that with a lexical semantic procedure, the semantic representation of the word is simultaneously retrieved, whereas, for the lexical non-semantic procedure there is no available semantic representation (i.e., the individual has the word stored in memory but does not know the meaning of the word). A deficit in the orthographic route results in difficulties reading words that are irregularly spelled and which cannot be correctly read through phonological decoding (e.g., “island”, “colonel”). On the other hand, words that are not represented in one’s mental lexicon must be read through a phonological procedure. Reading through the phonological route involves using letter-sound knowledge to pronounce words. This is commonly referred to as “decoding.” A deficit in the phonological route results in the inability to decode new words and made-up words (e.g., “gop”, “blat”). Figure 1.1 provides a simple illustration of the dual-route model. Figure 1.1.1 shows that in order to read aloud a phonologically regular word (such as “bus”), correct word recognition can occur by either using sight word memory or decoding. Figure 1.1.2 shows that a pseudoword (such as “blat”) can be correctly read by using decoding only. Using an orthographic route does not help because there is no mental representation of this made-up word in memory. Figure 1.1.3 shows that in order read aloud a phonologically irregular word (such as “island”), word recognition can only occur by using sight word memory (orthographic route). Using a decoding strategy will lead to an incorrect reading of the word.

Since there are two routes to reading in English, there are at least two routes to remediating a reading disability. Children with poor phonological processing can use their orthographic memory when encountering difficulties in reading. These children may be taught to remember commonly used words, thus minimizing the amount of cognitive effort required for word recognition and allocating more cognitive resources for extracting meaning from what is read. On the other hand, children with poor orthographic processing can rely more heavily on phonological processing in reading. Since most children with reading disability are in the former group (Martin, Pratt, & Fraser, 2000), the best known practice for reading instruction and reading intervention is to address the phonological route by teaching the sounds of the language and how to map these sounds to letters.

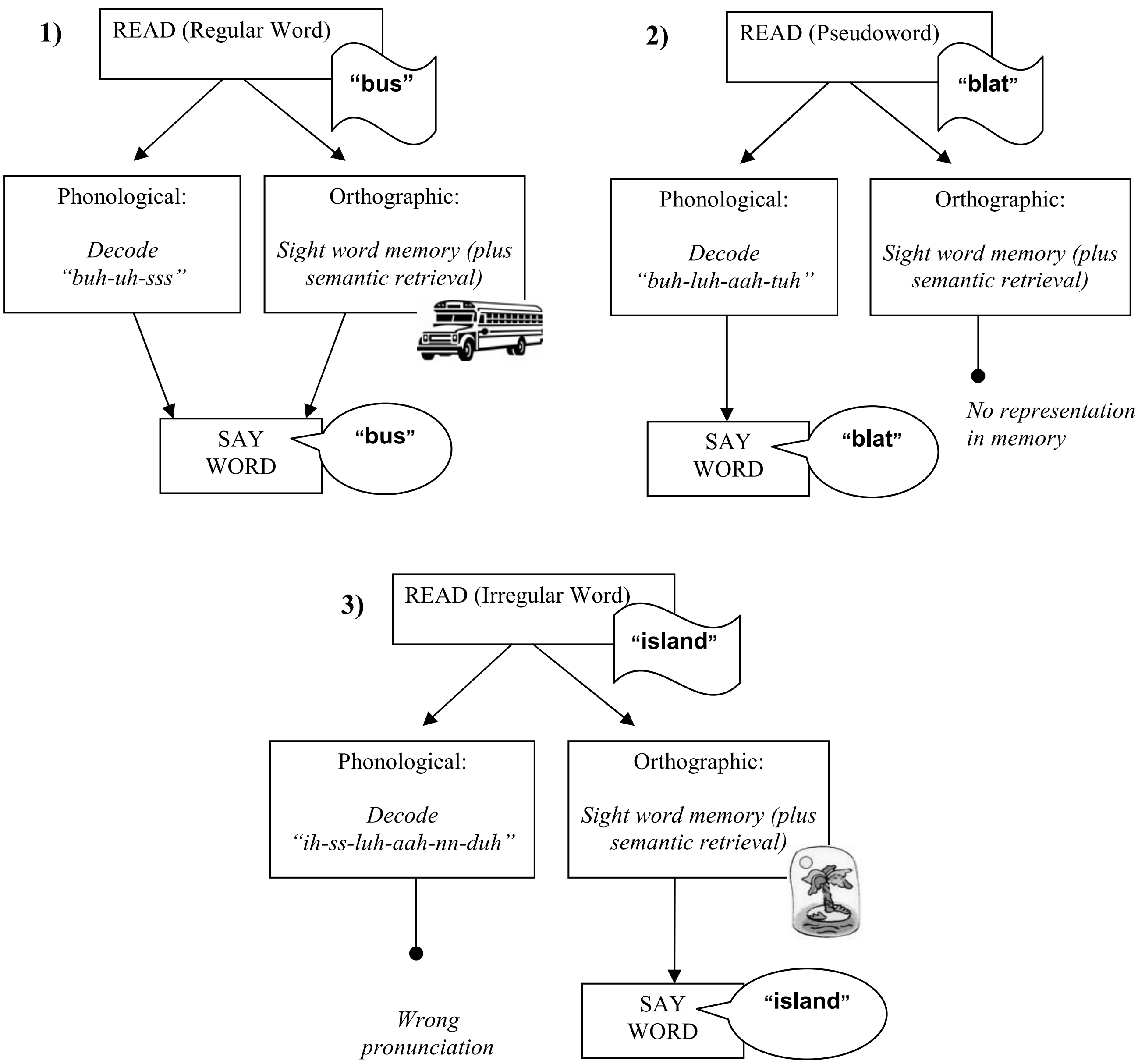

Figure 1.1. Dual-route model of reading. (1) Reading a regular word involves the phonological and/or orthographic routes. (2) Reading a pseudoword involves the phonological route. (3) Reading an irregular involves the orthographic route only.

The dual-route model has been applied to languages other than English, such as Spanish (e.g., Defior, Justicia, & Martos, 1996) and French (e.g., Doignon & Zagar, 2007). Differences in orthographic and phonological processing have also been found in EAL research. For instance, Wang and Geva (2003) found that while Chinese EAL children were less accurate at spelling pseudowords than L1 children, they performed at a higher level than L1 children in determining legitimate and illegitimate letter strings in English. The authors concluded that Chinese EAL children were more likely than L1 children to use a visual strategy rather than a phonological strategy. Similarly, Low and Siegel (2009) demonstrated that although Chinese EAL children were less efficient than L1 children at applying phoneme-grapheme correspondences to spell, they nevertheless performed comparably to L1 on a standardized test of spelling. In light of dual-route model, these findings suggest that Chinese EAL children may be more reliant on the orthographic route to compensate for a weaker phonological route.

Demonstrated by the above studies is that EAL children are not necessarily at a disadvantage in becoming literate in English even if their native language is highly disparate from English. EAL children can use strategies typical of good readers and spellers in their native language to navigate the English language. This is due to the benefits of cross-linguistic transfer.

Cognitive-Linguistic Processes of Reading

Cross-Linguistic Transfer of Language Skills

EAL children develop into competent classroom learners in spite of starting with a smaller repertoire of English language skills than L1 children. This supports the notion that cognitive-linguistic skills acquired in the first language can aid in the learning of additional languages. Thus, EAL children are not as behind as one would think. In fact, the universal framework, or developmental interdependence framework, posits that the development of literacy involves common underlying cognitive and linguistic processes crucial to the development of literacy skills across languages and writing systems (Cummins, 1979). Complimentary to the universal framework is the notion of cross-linguistic transfer. That is, if there are shared processes across languages, then the skills learned in a first language can be readily available and applicable to the learning of an additional language. Thus EAL children are not necessarily at a disadvantage in comparison to L1 children in the acquisition of English literacy skills.

A variety of research supports the notion of a universal framework by way of significant correlations between word reading skills across first and additional languages, and significant contributions of L1 cognitive-linguistic skills to additional language reading (Da Fontoura & Siegel, 1995; Manis, Lindsey, & Bailey, 2004). For instance, Durgunoglu, Nagy, and Hancin-Bhatt (1993) found that Spanish phonological awareness and Spanish word recognition were predictive of English word reading performance in a group of first-grade Spanish EAL students. Also, in a study of bilingual Portuguese-English speaking children, Da Fontoura and Siegel (1995) found that there was a significant relationship between the acquisition of word reading, decoding, working memory, and syntactic awareness in the two languages. The bilingual children who had lower reading scores in one language also had lower reading scores in the other language.

Cognitive-linguistic skills developed in the first language can be relatively strong predictors of concurrent and subsequent literacy skills in the additional language regardless of orthographic differences between languages (Campbell & Sais, 1995; Chow, McBride-Chang, & Burgess, 2005; Gottardo, Yan, Siegel, & Wade-Woolley, 2001). However, the transfer may be moderated by factors such as how closely the two languages match in terms of the sound-symbol relationships (Gholamain & Geva, 1999) with greater similarities leading to greater cross-linguistic transfer (e.g., Bialystok, Majumder, & Martin, 2003). For instance, alphabetic orthographies have sound-letter mappings whereas nonalphabetic orthographies (such as Chinese) do not. In addition, shallow (or transparent) alphabetic orthographies, such as Finnish and Italian, have more predictable sound-letter mappings than deep (or opaque) orthographies, such as English and French. However, a vast difference between language systems does not necessarily imply that second language processes will be adversely affected. Rather, it suggests that differences in the strategies that underlie second language literacy processes may be due to differences in orthographic elements of the languages.

A variety of studies have been conducted to determine which cognitive-linguistic skills are important for L1 reading acquisition and whether these cognitive-linguistic skills are also important for EAL reading acquisition. In addition to phonological processing, a growing body of research has also found that verbal working memory and syntactic knowledge play important roles in L1 and EAL literacy (Siegel, 1993). The influences of these three processes are so robust that many psycho-educational assessments for children at-risk for learning disabilities typically assess some or all of these processes.

Cognitive-Linguistic Predictors of Reading

Phonological Processing. It has been well established that phonological processing plays an important role in the early literacy acquisition of many alphabetic languages, such as English, Spanish, and Dutch (Durgunoglu et al., 1993; Manis et al., 2004; Patel, Snowling, & de Jong, 2004; Perfetti, 1985), and to a lesser extent for non-alphabetic languages where letter-sound mappings do not apply such as in the Chinese language (Jackson, Chen, Goldsberry, Ahyoung, & Vanderwerff, 1999; Tan & Perfetti, 1998). Phonological processing refers to a wide range of linguistic skills involving the processing and manipulation of speech sounds. How well a child can rhyme, segment sounds, blend sounds, and delete sounds are good measures of phonological processing (Yopp, 1988). Deficits in phonological processing are highly predictive of difficulties in literacy acquisition (Siegel, 1993), and the phonological deficits in reading disability persist over time (Shaywitz et al., 1999). A deficit in phonological processing impairs decoding, prevents word recognition, and hence prevents the reader from using his or her intelligence and vocabulary to extract the word's meaning.

Phonological processing is related to decoding – the association of phonological sounds to print. Decoding is measured by the accuracy of reading pseudowords, made-up words that can be correctly read using letter-sound knowledge (e.g., "sneck"; "mab"). A highly related skill is decoding fluency, which simply refers to speed of decoding in addition to accuracy. Similar to phonological processing, poor decoding is also highly predictive of reading disability (Da Fontoura & Siegel, 1995; Geva & Siegel, 2000). Fortunately, phonological processing and decoding can be remediated through direct and explicit instruction (National Reading Panel, 2000), thus making these prime targets for early screening. Although EAL children, by definition, have delayed exposure to the phonological structures of the English language, they are not necessarily at a disadvantage in English reading and spelling (e.g., for a review of EAL learners in Canada see Lipka, Siegel, & Vukovic, 2005).

Syntactic Awareness. Syntactic awareness, or grammatical sensitivity, refers to the ability to understand the way in which linguistic elements of a specific language are put together to form grammatically correct words and phrases. Syntactic awareness aids in fluent reading by helping the reader use the context to recognize the word. Thus, syntactic awareness is especially important for reading comprehension and oral reading fluency. However, syntactic awareness is important for word recognition as well. In a study of children in grades 1 through 3, Willows and Ryan (1986) found that syntactic awareness, as measured by an oral cloze task, explained a significant amount of variance in word recognition beyond that of age and cognitive ability. Syntactic awareness is also important for spelling. Muter and Snowling (1997) found that grammatical awareness, rather than phonological awareness, helped children to distinguish the orthographic aspects of spelling (e.g., choosing the correct spelling among word pairs that sound alike – "skait" vs. "skate").

In studies of EAL children, syntactic skills in the native language and in English were found to be significantly correlated with reading skills across languages (e.g., Portuguese – Da Fontoura & Siegel, 1995; Hebrew – Geva & Siegel, 2000; Arabic – Abu-Rabia & Siegel, 2002). Syntactic awareness has also been found to be disrupted in children with reading disability in languages other than English (Bentin, Deutsch, & Liberman, 1990; Da Fontoura & Siegel, 1995; Plaza & Cohen, 2004; So & Siegel, 1997). However, EAL children's knowledge of English syntax lagged behind that of their English L1 peers. Da Fontoura and Siegel (1995) found that despite similar word reading performance, Portuguese-English bilingual children performed significantly lower on an oral cloze task than L1 children. This finding was replicated with Punjabi-English bilingual children (Chiappe & Siegel, 1999) and with a diverse EAL group (Lesaux & Siegel, 2003; Low & Siegel, 2005). However, in reviewing a number of studies Lipka et al. (2005) found that differences may be mediated by orthographic similarity between English and the native language, or by increased exposure to English language learning as evidenced by EAL children performing similarly to L1 children by middle childhood.

Verbal Working Memory. Working memory is a limited capacity cognitive system that allows for the temporary storage and manipulation of information necessary for cognitive tasks, such as learning and reasoning. Working memory is analogous to holding information "online" while continuously updating and integrating information during the completion of a cognitive task. Working memory is proposed to consist of at least three main components – a visual working memory component, a verbal working memory component, and a system that coordinates the two. Baddeley and Hitch (1974) have labeled these components the visuospatial sketchpad, the phonological loop, and the central executive. The central executive refers to an attentional-controlling system responsible for the coordination of information from the two subsidiary storage systems. The visuospatial sketchpad is involved with visual imagery while the phonological loop temporarily stores and rehearses phonological or linguistic information. More recently, Baddeley (2000) proposed that there was, in fact, a third subsidiary system called the episodic buffer which integrates the working memory system with the processes for long-term memory storage. Undoubtedly, working memory underlies all aspects of learning and thus is central for reading and spelling. Of interest in this study is verbal working memory (i.e., the phonological loop). Weak memory for language-based material limits the ease with which an individual is able to process, organize, and hold verbal information that is necessary for following instruction and building up stores of knowledge. There may be difficulty remembering oral instructions, particularly in noisy environments typical of classrooms. Poor working memory also contributes to errors on a variety of learning tasks such as spelling, mathematics, decoding, and writing. For instance, poor readers may exert so much of their mental effort towards decoding that inefficient working memory resources remain for reading comprehension.

A study of L1 children found that although verbal working memory grows with age, poor readers are consistently behind normally achieving readers regardless of age (Chiappe, Hasher, & Siegel, 2000). Additionally, poor readers have difficulty preventing irrelevant information from intruding into working memory. The authors attributed these intrusion errors to poor inhibitory control. Poor working memory is also connected to reading disability languages other than English, such as Chinese (So & Siegel, 1997), Hebrew (Geva & Siegel, 2000), and Portuguese (Da Fontoura & Siegel, 1995). However, there has been mixed results regarding the verbal working memory performance of EAL children. For instance, Lesaux and Siegel (2003) found that the significant difference in a sentence memory task between L1 and

EAL children at the beginning of kindergarten had disappeared by the end of grade 2. In contrast, using a similar task Jongejan, Verhoeven, and Siegel (2007) found that the significant gap in verbal working memory between L1 and EAL children remained stable from kindergarten to grade 4. In their review, Lipka and colleagues (2005) proposed that discrepant findings can likely be explained by the fact that performance on verbal working memory tasks grows with oral linguistic proficiency. Thus as EAL children become more proficient with the language there are decreases in the observed differences in English verbal working memory. Another explanation provided by Swanson, Saez, and Gerber (2006) was that the salience of working memory in learning an additional language becomes more language specific across time. That is, for early readers a combination of working memory skills developed in both languages predict reading ability, but by third grade working memory skills in the native language are better predictors of English reading than English working memory.

Studies on Reading Development

There is some evidence to suggest that reading growth for L1 children is characterized by a high rate of growth initially, followed by a slower rate of growth, and an eventual plateau (Lesaux et al., 2007; Shaywitz et al., 1999; Speece, Ritchey, Cooper, Roth, & Schatshneider, 2004). Furthermore, the pattern of growth can be differentiated for good and poor readers. The first pattern is characterized as a deficit model and proposes that poor readers initially start out with lower reading achievement (lower intercept) but experience similar rates of growth (similar slope) as normally achieving readers. The second pattern is characterized by a developmental lag. According to this model, poor readers initially start out with lower reading achievement (lower intercept) but have accelerated rates of growth (steeper slope) and eventually may catch up to their normally achieving peers. The third possible growth pattern is characterized by accumulating deficits in which "the rich get richer and the poor get poorer." Poor readers start out with lower reading achievement (lower intercept) and progress at a slower rate (flatter slope). This pattern has also been named the "Matthew effect."

In one of the longer longitudinal growth modeling studies, Shaywitz et al. (1999) found that L1 reading showed quadratic growth between grades 1 through 12 with the greatest rate of growth occurring early in the trajectory followed by a slower rate of growth and eventually a plateau in early adolescence. The authors further found that this developmental pattern was characteristic of both normally achieving and poor readers. Although the two reader groups showed similar developmental curves, the poor readers had lower initial reading achievement, and thus the gap in reading achievement persisted over time (i.e., developmental deficit). The developmental deficit model also explained the reading development for Spanish EAL children with reading difficulties. Swanson, Saez and Gerber (2006) followed a cohort of Spanish EAL children from grades 1 through 3 and found that the development of reading skills for EAL poor readers was characterized by the deficit model (i.e., lower intercept, similar slope values).

More recently, studies have shown heterogeneity in early developmental pathways for children with reading disability. Parrila, Aunola, Leskinen, Nurmi, and Kirby (2005) tracked the yearly reading development of L1 children from grades 1 through 5. Using latent growth modeling, Parrila et al. found that word recognition, decoding, and reading comprehension followed a quadratic growth trend. That is, the rate of growth slows over time. The authors then used growth-mixture modeling to investigate heterogeneity in pathways. For word recognition, decoding, and reading comprehension there were at least two latent classes of readers. A class of "consistently good" readers was characterized by high initial status, positive linear growth, and moderate deceleration. A class of "consistently poor" readers was characterized by low initial status, positive linear growth, and somewhat slower deceleration. The gap between the good and poor readers was persistent but not cumulative across time, thus providing evidence for a developmental deficit model for poor readers. However, for decoding and reading comprehension, a third class of readers was present. This third class was characterized by low initial status and steepest growth over time compared to the other groups, thus “catching up” over time.

Other studies on reading development also found subgroups of readers but the focus was on the profiles of subgroups rather than the shape of growth. Lyytinen et al. (2006) followed 200 Finnish children from birth to the start of the second grade, half of whom had a family history of reading difficulties. The children were monitored yearly on skills such as receptive language, expressive language, morphological awareness, phonological awareness, letter knowledge, short-term memory, and rapid naming. In grades 1 and 2, the children were assessed in reading and spelling which formed the overall composite measure for reading. Using a growth mixture model, the authors found evidence for four subgroups of children. The first group followed a “typical” trajectory in which good early pre-reading language skills were followed by adequate development of reading skills into early school age. These children had the highest reading scores at school age. Children in the “declining” group showed cumulative weaknesses in pre-reading language skills leading up to school age. They subsequently scored the lowest of all four groups on the composite measure of reading. The third “dysfluent” group showed appropriate development of phonological skills and verbal short term memory but cumulative weaknesses across other skills. At school age they scored just above the “declining” group on the composite measure of reading. Of surprise was the “unexpected” group who had cumulative weakness in letter knowledge and difficulties in early reading acquisition despite relatively strong development in early pre-reading language skills, such as phonology, morphology, language, rapid naming, and memory. The authors suggested that in a consistent orthography, as is Finnish, poor letter knowledge can compromise reading development despite relatively good language skills and memory. In general, the largest proportion of poor readers at the end of grade 2 had a family history of reading difficulties and belonged either to the “dysfluent” or “declining” subgroups. The children in the “unexpected” group showed slow-but-accurate reading at the end of grade 2.

Lipka, Lesaux, and Siegel’s (2006) study on Canadian children also supported this notion of heterogeneity and “unexpectedness.” The authors conducted a retrospective analysis of children who were identified as having a reading disability in fourth grade and found three different profiles for children with reading disability. The first group was referred to as “poor readers” who were first identified as at-risk in kindergarten and continued to have significant reading problems through to grade 4. The “borderline” group was characterized by slight fluctuations in and out of the range of reading disability though their reading achievement was generally low. The third group was characterized as “late emergers” whose reading difficulties did not become evident until middle childhood. Although Lyytinen et al. (2006) found that a late emerging group can be identified by the beginning of second grade, Lipka et al. found that late emergers were not identified until the fourth grade. This can be explained, in part, by the regularity of the Finnish language in comparison to the English language and the corresponding ease in the early identification of reading and decoding problems in Finnish. In the Finnish language, children are expected to reach decoding mastery within the first several months of reading instruction (Lyytinen et al.). In contrast, many words in English require a combination of sight memory and decoding ability, and thus late emergers may use sight memory to help compensate for decoding until the strategy becomes insufficient (Lipka et al.). In summary, there is no disagreement about the persistent nature of reading difficulties through later childhood and adulthood. Although there is evidence to suggest parallel patterns of growth for children with and without reading disability, there is also evidence to suggest heterogeneity of growth for children with reading disability. Although most paths are characterized by some early or persistent predictors of later reading difficulties, there is at least a path in which reading difficulties cannot be easily characterized or predicted early on. This finding has been shown in children learning to read in shallow orthographies (e.g., Finnish) as well as deep orthographies (e.g., English).

In contrast to English L1 research, comprehensive descriptions of growth across different literacy skills for EAL children are extremely rare. To date there is only a small selection of published studies that have investigated growth models for EAL children. The first was that of Lesaux et al. (2007) who reported on the development of word recognition skills of Canadian L1 and EAL children from kindergarten to grade 4. The sample represented an entire school district in which all children were enrolled in the same rich literacy program. The authors found that the development of word recognition was invariant for L1 and EAL children as evidenced through multi-group latent growth analyses. That is, the two language groups were equal in where they started and how they grew over time. The shape of growth for both language groups was one that slows over time. Second, a study by Kieffer (2011) found that growth in reading skills for EAL children living in the United States can be differentiated based on their level of oral language proficiency upon school entry. Kieffer used the Early Childhood Longitudinal Study which followed American children nation-wide from kindergarten to grade 8. The children were grouped into L1, EAL with fluent English proficiency, and EAL with limited English proficiency. A piece-wise latent growth model was fitted with three distinct growth periods with rates of change that slowed over time (kindergarten to grade 1, grades 1 to 3, grades 3 to 8). Differences among groups were represented through the use of dummy predictors regressed on the latent growth factors. Kieffer's reading measure was a composite of print knowledge, familiarity with phonemes, decoding, vocabulary, and six types of reading comprehension skills. Kieffer found that EAL children, regardless of oral language proficiency, scored lower than L1 children at school entry. However, the two EAL groups differed in their rates of growth. EAL children with limited English proficiency never caught up despite having a higher rate of growth than L1 children. In fact, they were two years behind the national average in grade 8. In contrast, EAL children with fluent English proficiency caught up by the middle of grade 1 and continued to grow similarly to L1 through to grade 8. Upon further analyses, Kieffer found that the effects of oral language proficiency were reduced by one-half to two-thirds when SES and poverty were taken into consideration. When SES and poverty were controlled for in the model, it was found that EAL children were either comparable or performing at a higher level than L1 children by grade 8. However, EAL children living with low SES and poverty continued to be at-risk. Another study by Kieffer and Vukovic (2011) followed 73 L1 and 93 EAL children from grades 1 through 4 attending two urban schools in the city of New York. The reading program differed between the two schools, but both were essentially phonics-based. The EAL children were predominantly Spanish speakers who made up over half of the student population in the two schools. Quadratic growth models were constructed for word recognition with language status as a dummy predictor. Kieffer and Vukovic found that there was a difference in initial status with EAL children scoring lower than L1 children. Since there was no difference in the rates of change over time, there was a persistent but not cumulative gap between the word recognition skills of L1 and EAL children.

In the end, there is no prevailing model of literacy development for EAL children. As highlighted in the studies above, differences in methodology and population make it difficult to compare and contrast across studies. For instance, Lesaux et al. (2007) and Kieffer (2011) focused on samples that were more representative of larger populations. In contrast, Kieffer and Vukovic (2011) studied mainly Spanish-speaking children from low income backgrounds attending two urban schools in one city. Almost all children in their study were of non-Caucasian descent and the large majority of the school population was EAL. Thus Kieffer and Vukovic's finding of a persistent deficit might be more generalizable to populations with multiple risk factors. The amount of information on the methods of classroom instruction and quality of educational programming were also insufficient to explore the effects of instruction in helping EAL children succeed in reading. The children in Lesaux et al.'s study received evidence-based reading instruction where the particular goals and strategies were consistent across all grades for all children in the school district. The children in Kieffer and Vukovic's study received phonics-based instruction, but the instruction varied year by year. Information on programming was not available for Kieffer's study as it included an entire nation of schools which is likely to have large variations. Where Kieffer found significant effects of SES for US children, Lesaux et al. did not for Canadian children. It was noted by Lesaux et al. that the EAL children lived in the same neighbourhoods as the L1 children, thus SES was not a confounding factor. As noted by Lesaux et al., this is in contrast to EAL children living in the United States who tend to be clustered in low SES neighbourhoods. This was perhaps the case for the attenuating effects of SES found in Kieffer's study. Kieffer and Vukovic did not explore the issue of SES although most of the children came from a similarly low SES background regardless of language. Despite methodological differences there is some convergence from the two studies focusing on EAL children from diverse linguistic backgrounds. Both Lesaux et al. and Kieffer concluded that although EAL children enter school with lower oral language skills they are not necessarily at a disadvantage.

In summary, the bulk of the available literature reports on the growth models for L1 children and the characteristics of good and poor readers. Among these L1 studies, most focus on the short-term outcomes of early reading development, such as the first few years. Since development is likely different for early and later reading, a long-term analysis would contribute to the understanding of how reading grows and for whom. The research on the comparability of models for L1 and EAL reading development are scarce. There have only been a few published studies to date which examine growth past the initial years. However, there is yet to be a comprehensive description of how varying literacy skills develop for EAL children.

CHAPTER 3: METHOD

To add to the extant body of literature, this chapter explores whether there are common developmental models for L1 and EAL children across a variety of literacy tasks. The predictive value of a set of cognitive-linguistic skills is evaluated. Also examined is the influence of having a reading difficulty on the later development of literacy skills and whether the growth is different for L1 and EAL children who are poor readers.

Participants

The data were drawn from a larger longitudinal project examining the reading skills in a cohort of children from 30 schools in the North Vancouver school district. The longitudinal project began in the kindergarten year and was completed in the ninth grade. There were approximately 1,700 children who participated over the course of the ten years. Standardized testing for the reading measures began in kindergarten, whereas standardized testing for spelling did not begin until grade 2. Since the focus of this study was on both reading and spelling, this study reported on the data of children who participated from grades 2 through 7. In order to be included in this study, a child must have been in at least two time periods including the first time period (grade 2). Additionally, each child must have a complete set of data for the grade 2 measures. This effectively resulted in a potential sample size of 955 children with 58% of those participating in all six time periods, 20.9% in five time periods, 9.7% in four time periods, 6.6% in three time periods, and 4.7% in two time periods. As the sample was an entire school district, a range of socioeconomic status (SES) was represented. The relationships between SES and early literacy skills in this population were examined by D'Angiulli, Siegel, and Hertzman (2004). The authors found strong associations between SES and reading, phonological processing and spelling at the beginning of kindergarten. However, these associations were mostly non-significant by grade 1. Thus, it is less probable that the results of the present study are confounded by SES since the study examines grade 2 onward.

Rich Literacy Program

The school district involved was committed to the intervention and prevention of literacy difficulties. All children in the school district received the same reading instruction. The core foundation was a scientific, research-based model of general reading instruction indicated for all children and particularly for those who struggle to learn to read. The overall reading program, called Reading 44, included three modules. In the module called “Firm Foundations”, the children received systematic and direct instruction in evidence-based reading techniques, such as those from “Launch into Reading Success” program (Ottley & Bennett, 2000). The children learned about sound-symbol relationships. They also participated in independent activities, such as cooperative story writing and journal writing using invented spelling. Secondly, the program consisted of six reading components: guided reading, shared reading, reading/writing connection, home reading program, independent reading, and read aloud and respond. Thirdly, the children were taught 12 reading strategies (referred to as the “daily dozen”). The modules were delivered in the classroom and in small-group activities.

Another essential element was the measuring and monitoring of children’s progress in response to the instruction. In the fall and spring of kindergarten, children received universal district-wide screening of reading, spelling, and math to help identify those children who needed closer monitoring or additional intervention. It should be noted that although specific criteria were applied in order to determine risk status, the intervention was provided without requiring the assignment of learning designations or diagnoses. This allowed every child who was struggling, for whatever reason, to access needed intervention. Children found to be at risk for reading failure received further small group intervention three to four times a week, for 20 minutes at a time. They continued to receive small group support four times a week in succeeding grades. The structure of the program remained unchanged each year although the focus of the instruction varied based on the learning needs at each year.

Procedure

Each child participated in two testing session across two different days. The spelling and reading comprehension tasks were administered in a group setting in the classroom. All other measures were administered individually to each child in a quiet room separate from the child's classroom. Data collection occurred in the schools each spring term. The research team consisted of trained graduate and undergraduate students from the areas of education, psychology, and other related social sciences. The examiners were trained on all measures prior to the data collection process. Supervision was provided by the project coordinator and designated research team leaders. Quality monitoring included reviewing of the protocols for accuracy and completeness during the data collection process, and reviewing of the accuracy of scores during the data entry process.

Classification of Language and Reader Group

Language Group

For the purpose of this study, children were considered as EAL if they spoke a language other than English at home to their parents, grandparents, and siblings; and if a language other than English was their first language. Language information was initially obtained from school records and later verified with individual students. The EAL children came from a variety of linguistic backgrounds. The sample included 32 different languages. The predominant non-English native languages were Chinese (including Cantonese and Mandarin) and Persian. Within the sample there were 773 L1 and 182 EAL children. About half of the EAL children were born in Canada, while others immigrated to Canada at an early age. About 57% learned to speak English after the age of 3, and about 13% of the EAL children learned to speak English prior to the age of 3. The age of acquisition was missing for the remaining 30%. Aside from syntactic awareness as measured through oral cloze ($p < .001$), the initial status of each cognitive-linguistic skill was similar across language groups (Table 3.1)

Table 3.1

Grade 2 cognitive-linguistic skills by language status

	Mean (SD)		Effect Size (*d*)
	L1	EAL	
Cognitive-linguistic measures			
Working Memory for Words (max. 12)	3.49 (1.55)	3.30 (1.69)	
Oral Cloze (max. 11)	7.56 (1.70)	6.57 (2.09)	.52
Rosner's AAT (max. 30)	21.74 (6.03)	21.75 (6.29)	

Cohen's *d*: small=.20, medium=.50, large=.80

Reader Group

Children were classified as normally achieving readers (NA) or poor readers (PR) based on their word recognition skills measured in grade 2 on the Reading subtest of the Wide Range Achievement Test-3 (WRAT-3; blue form; Wilkinson, 1993) and the Word Identification test of the Woodcock Reading Mastery Test – Revised (WRMT-R; Form G; Woodcock, 1987). Children were classified as poor readers if either score on the WRAT-3 or WRMT-R was at or below the 25th percentile. Children were classified as normally achieving readers if both scores were at or above the 35^{th} percentile. The criteria classified 63 children (53 L1 and 10 EAL) as poor readers in grade 2. The prevalence rate of poor readers was 6.6% for the entire sample. The prevalence rates were 6.9% for L1 children and 5.5% for EAL children. The criteria also classified 828 children (662 L1 and 166 EAL) as normally achieving readers. Sixty-four children (58 L1 and 6 EAL) with borderline reading skills within the 26th and 34th percentile range were not classified into any reader group using the criteria. As shown by Table 3.2, the PR group had significantly lower cognitive-linguistic skills than the NA group (*ps* < .001).

Table 3.2

Grade 2 cognitive-linguistic skills by reader status

	Mean (SD)		Effect Size (*d*)
	NA	PR	
Cognitive-linguistic measures			
Working Memory for Words (max. 12)	3.52 (1.59)	2.78 (1.41)	.49
Oral Cloze (max. 11)	7.54 (1.79)	5.70 (1.69)	1.06
Rosner's AAT (max. 30)	22.57 (5.68)	14.60 (6.02)	1.36

Cohen's *d*: small=.20, medium=.50, large=.80

Measures

Longitudinal Measures

Word Recognition: Wide Range Achievement Test-3: Reading Subtest (blue form; Wilkinson, 1993). The WRAT3 Reading subtest is a standardized measure of word recognition accuracy. The child was asked to read aloud as many words as possible from a list of words of increasing difficulty. Administration was discontinued when ten consecutive errors were made. This measure was administered from grades 2 through 7. Since the same edition was administered longitudinally, raw scores were used for the latent growth analyses. The maximum possible raw score was 57.

Word Reading Fluency. Word reading fluency refers to the accuracy and speed of word recognition. Although word reading fluency was measured from grades 2 through 7, repeated measures analyses for the entire growth period was not examined because the measure changed over time. Since the same measure was used from grades 3 through 6, latent growth analyses were conducted for the four time periods. The tan form of the WRAT-3 Reading subtest was used to develop the word reading fluency list. The child was asked to read aloud as quickly as possible a list of word of increasing difficulty. Administration was discontinued after one minute. The maximum possible score was 42.

Decoding: Word Attack (Woodcock, 1987; Woodcock & Johnson, 1989). The Word Attack test is a standardized measure of phonological decoding, or the application of grapheme-phoneme correspondences. The child was asked to read aloud a list of pseudowords of increasingly difficulty. Administration was discontinued when all items on a given level were failed. The version from the Woodcock Reading Mastery Test – Revised (Form G) was used in grade 2, and the version from the Woodcock-Johnson Psycho-Educational Battery-Revised (Form A) was used in grades 3 through 7. Although different editions were used longitudinally, the Word Attack tests provide a vertical developmental metric (W score) that can be directly compared across editions. The W-scale is a special transformation of the Rasch scaling and thus is particularly useful for measuring development. W scores were used for the latent growth analyses.

Decoding Fluency. Decoding fluency refers to the accuracy and speed of decoding. Although decoding fluency was measured from grades 2 through 7, repeated measures analyses for the entire growth period was not examined because the measure changed in grade 7. However, the same measure was used from grades 2 through 6, thus latent growth analyses were conducted for the five time periods. Form H of the WRMT-R was used to develop the word list for grades 2 through 6. The child was asked to read aloud as quickly as possible a list of pseudowords of increasing difficulty. Administration was discontinued after one minute. The maximum possible raw score was 45.

Reading Comprehension: Stanford Diagnostic Reading Test (form J; Karlsen & Gardner, 1994). The SDRT is a standardized reading comprehension test whereby each child was asked to read short passages from a booklet and respond to multiple-choice questions about each passage within a time limit. The SDRT provides incremental levels for individuals from grade 1 through college. The children were administered the appropriate levels each year for a total of four levels from grades 2 through 7. The SDRT uses vertical equal interval scaling, and thus the standard scores from each grade are particularly useful for monitoring growth. Standard scores were used for the analyses.

Spelling: Wide Range Achievement Test-3: Spelling Subtest (blue form; Wilkinson, 1993). The WRAT3 Spelling subtest is a standardized measure of single word spelling. The child was asked to spell, to dictation, words of increasing difficulty. This measure was administered from grades 2 through 7. Since the same edition was administered longitudinally, raw scores were used for the latent growth analyses. The maximum possible raw score was 55.

Grade 2 Measures

Word Recognition: Woodcock Reading Mastery Test – Revised (Form G): Word Identification (Woodcock, 1987). The WRMT-R Word Identification test is a standardized measure of word recognition. The child was asked to read aloud a list of words of increasing difficulty. Administration was discontinued when all items on a given level were failed.

Verbal Working Memory: Working Memory for Words (Siegel & Ryan, 1989; Willows & Ryan, 1986). The child was orally presented with a set of sentences missing the final words. The child was then asked to provide the missing word to complete each sentence. To minimize word finding, the sentences were chosen so that the final word was virtually predetermined. The child was then asked to repeat the words that s/he provided for the end of each sentence, in order. The number of sentences in each set increased, beginning with two sentences and increasing by an additional sentence, up to a possible five sentences (2, 3, 4, 5). Sample sentences include: *"Running is fast, walking is ___. At the library people read ___. An apple is red, a banana is ___."* Administration was discontinued when all items on a given level were failed. The maximum score on this task was 12. The Working Memory for Words task is provided in Appendix A.

Syntactic Awareness: Oral Cloze (Willows & Ryan, 1986). An oral measure rather than written measure of syntactic awareness was chosen to prevent any confounding effects of reading ability. Eleven sentences were read to the child. After hearing each sentence, the child was asked to provide the missing word that would complete the sentence. In order for the response to be considered correct, the word must be semantically and syntactically appropriate. Sample sentences include: "*The moon shines bright in the* ____.", and "*The children*___ *with the toys.*" The maximum score was 11. The Oral Cloze sentences are listed in Appendix B.

Phonological Processing: Rosner's Auditory Analysis Test (Rosner & Simon, 1971). The child was asked to say a word and then to say the word again without one of its syllables (e.g. "cowboy" without the /boy/ sound) or without one of its phonemes (e.g. "coat" without the /k/ sound"). The child was asked to delete syllables and single phonemes from the initial, middle, and final positions in words. There were 30 items arranged in order of difficulty. Administration was discontinued when 5 consecutive errors were made. The maximum score on this task was 30.

Data Analyses

Data were analyzed with latent growth model (LGM)/ structural equational modeling (SEM) techniques using the Mplus V6.12 program. LGM allows for the examination of the growth form and the association between the initial level of achievement and subsequent growth. In the same analyses, LGM also allows for the examination of heterogeneity, or individual differences. SEM techniques are traditionally known for use in large sample sizes. However, more recent research has shown that LGM can hold up well to relatively small sample sizes, but it ultimately depends on a variety of factors such as the specified model, psychometric properties of the measures, missing data, and size of effect (Muthen & Muthen, 2002).

It is not uncommon to have missing data in a longitudinal study of this length. The percentage of missing data varied from year to year, with 2.7% in grade 3, 6.7% in grade 4, 22.1% in grade 5, 17.9% in grade 6, and 30.1% in grade 7. In reviewing the missing data patterns, some patterns indicate drop out over time while other patterns indicate intermittent missingness (individuals coming in and out of the study). The data were assumed to be missing completely at random (MCAR) or missing at random (MAR). MCAR is true if the data is missing completely at random. MAR relates to missingness that can be related to the observed variables. Growth modeling is especially well suited for longitudinal data as it allows for missing data to be modeled, as long as the model fitting is correct. To maximize the use of all available data, missing data was modeled using full information maximum likelihood (FIML) estimation. That is, the estimated values for the missing data are values that maintain the variance-covariance matrix (i.e., reproduce the observed data). There are other ways to handle missing data, such as listwise deletion, but this is not suitable for this particular study. Listwise deletion, that is to delete any individual who does not have data on all time points, will lead to a depleted sample. This can lead to inefficient estimates under MCAR and problems in the parameter estimates and standard errors under MAR. The FIML approach is well accepted in longitudinal modeling and has been shown in Monte Carlo studies (e.g., Enders & Bandalos, 2001) to provide either equal or more accurate estimates than other approaches to missing data.

Data-Model Fit

In evaluating the global fit of the latent growth models, several fit statistics were considered: χ^2 test, root mean square error of approximation (RMSEA), and comparative fit index (CFI). A non-significant χ^2 test is indicative of a good fitting model. However, given what is known about the sensitivity and power of the χ^2 test to reject the null hypothesis, the evaluation of the global fits were based on the RMSEA and CFI values. The χ^2 test values were provided for comparison. A RMSEA value of less than 0.05 suggests a good fit, a value of 0.05 to 0.08 suggests an adequate fit, a value of 0.08 to 0.10 suggests a mediocre fit, and a value over 0.10 suggests a poor fit (Browne & Cudeck, 1992; MacCallum, Browne, & Sugawara, 1996). CFI values of greater than 0.95 signify a good fitting model (Hu & Bentler, 1999).

Model Building

Unconditional Models. For each outcome measure, visual inspection of the plotted individual trajectories and plotted group means were completed. A linear model of development from grades 2 through 7 was first specified and tested, and then followed by a nonlinear model to determine whether the fit improved (i.e., nested model testing). Then unconditional growth models were specified separately for L1 and EAL children to ascertain fit for each group. These separate models were used to inform the specifications for the baseline multi-group latent growth models (MG-LGM).

In a MG-LGM, models for L1 and EAL were fit simultaneously. This allows for hypothesis testing of invariance (equality) of parameters across groups. Nested model testing was used to examine differences across groups in initial levels of achievement and change over time. The same sequence of nested model testing was conducted for word recognition, decoding, reading comprehension, and spelling. In order to test whether the LGM measurement model (growth parameters) was equal for L1 and EAL children, nested model comparison was conducted where subsequent models imposed an increasing number of restrictions on selected parameters. First estimated was a multi-group LGM in which the shape of growth (e.g., number of growth factors, loading patterns and coefficients, regression on intercept) was constrained to be equal across groups. All other parameters were freely estimated. To compare the fit of the nested models, the difference between the CFI of the models was used to evaluate whether there was invariance (i.e., equality). Cheung and Rensvold (2002) showed that, unlike the χ^2 change, the CFI change is independent of model complexity and sample size. A change in CFI of equal to or less than 0.01 ($\Delta_{CFI} \leq 0.01$) indicates that by imposing the equality constraints, the model fit did not significantly worsen. That is, the specific parameters can be considered invariant across groups. The second step to evaluating measurement invariance is by constraining the residual variances of the outcome variables to be equal across groups. Although there is disagreement about whether constraining residual variances is necessary for measurement invariance, incorporating this extra step explores whether there are unmodeled sources of variance that systematically influence one group's performance (e.g., Wu, Li, & Zumbo, 2007). In satisfying the two equality conditions (growth form and residual variances), one can consider the measurement model to be equal, or invariant, across groups. Subsequent to determining measurement invariance, the structural parameters were tested. Whereas the measurement parameters describe the relationship between the observed variables and the latent factors (e.g., growth shape), the structural parameters describe the distribution of and relationship among the growth factors. The structural parameters include the factor means, factor variances, and factor covariances.

Predictor (Conditional) Models. Next, a sequence of MG-LGMs tested whether certain variables (such as cognitive-linguistic skills and reader group status) predicted initial levels and rates of change in achievement across L1 and EAL children. This was achieved by introducing the predictor variables as exogenous covariates in the MG-LGM. The regression coefficients were freely estimated. This was compared to a model in which regression paths were constrained to be equal across groups.

CHAPTER 4: RESULTS

The first two aims of this study were to model the development of literacy skills for L1 and EAL children. So in answering research questions one and two, a series of unconditional and conditional LGMs were estimated for each of the longitudinal measures: word recognition, word reading fluency, decoding, decoding fluency, reading comprehension, and spelling.

Development of Word Recognition for L1 and EAL Children

Word Recognition: Unconditional Model

The shape of growth was selected based on findings from existing literature, a visual inspection of the plotted individual trajectories, and nested model testing. The best fitting model to the word recognition data was quadratic rather than linear in form. In other words, the deceleration in the rate of change over time could not be accounted for by a simple linear model that assumes a constant rate of change over time. To illustrate this, a plot of observed raw score means for each group is shown in Figure 4.1.

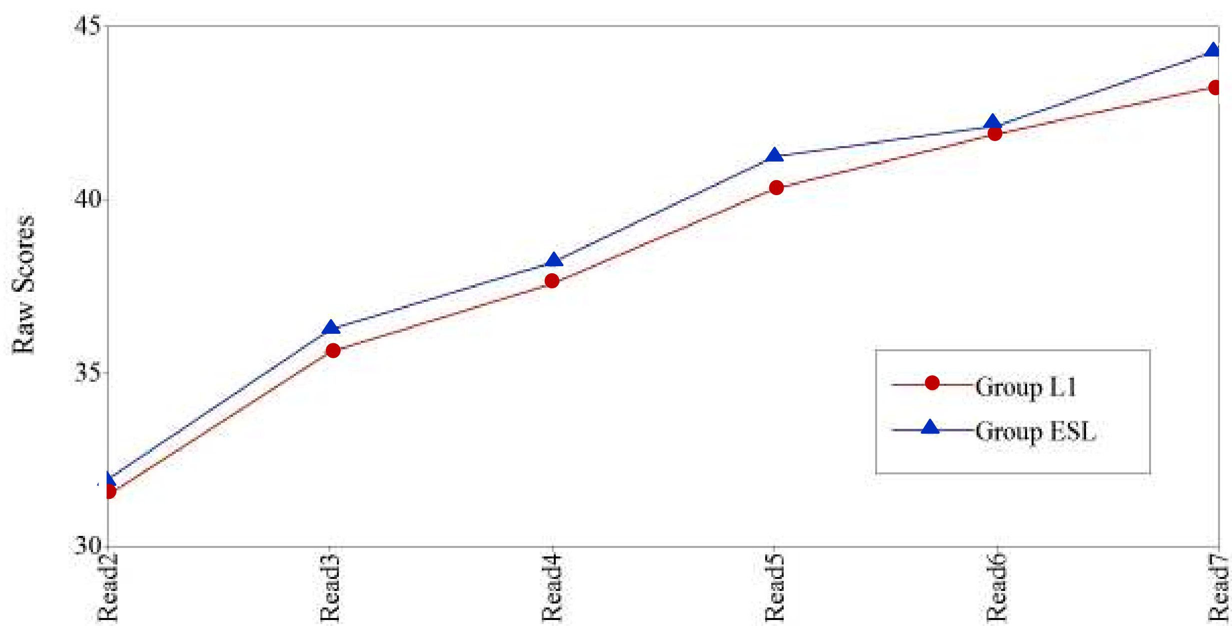

Figure 4.1. Plot of observed group means for word recognition.

In a quadratic model (Figure 4.2), three growth factors are estimated: the intercept (initial level), the linear slope, and the quadratic slope.

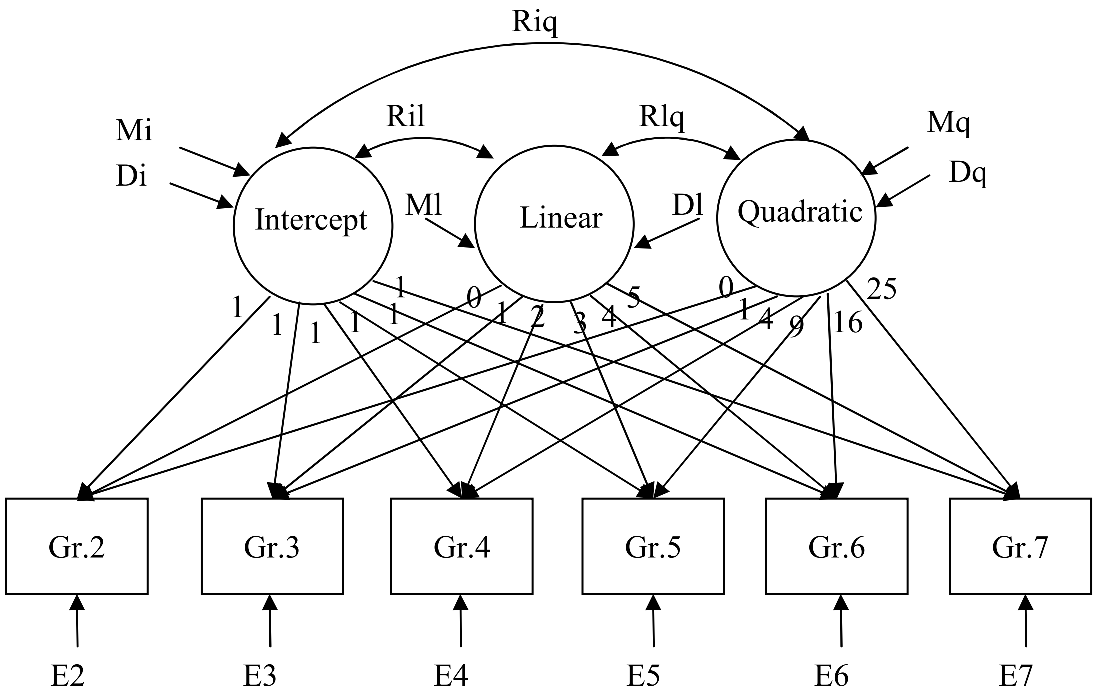

Figure 4.2. Representation of an unconditional quadratic growth model.

The circles represent latent growth factors. The mean of the intercept (Mi) represents the average group achievement in grade 2. The variance of the intercept (Di) reflects the individual differences in grade 2. The means of the linear and quadratic slopes (Ml and Mq) represent the group's average rate of change, and the variances of the linear and quadratic slopes (Dl and Dq) reflect the variation in individual rates of change. The residual variances represent measurement error or possibly other sources of variation unaccounted for by the model (E2, E3,…E7). The intercept and slope factors were allowed to co-vary as indicated by the curved line with double arrows (Riq, Ril, Rlq). Since the intercept growth factor is constant across time for any given individual, its factor loadings were fixed at 1. The linear slope factor describes the constant rate of change across time. Thus, the factor loadings for the linear slope were fixed in ascending order to specify values corresponding to a linear time scale (e.g., 0, 1, 2, 3, 4, 5).

The quadratic growth factor (e.g., 0, 1, 4, 9, 16, 25) captures the upturn or downturn over time beyond what is predicted by the linear factor.

Models were initially fit separately for L1 and EAL children. Fit indices for each group indicated adequately fitting models – L1: RMSEA = .077, RMSEA 90% CI = .059 - .095, CFI = .979, $\chi^2(12) = 66.364$, $p < .001$; EAL: RMSEA = .089, RMSEA 90% CI = .048 - .130, CFI = .955, $\chi^2(12) = 29.231$, $p < .01$. The findings of the LGMs were then incorporated into a baseline MG-LGM which tested for equality of model parameters across language groups. Table 4.1 summarizes the results of the invariance analyses.

Table 4.1

Nested models for unconditional MG-LGM of word recognition

Model	RMSEA	CFI	Δ_{CFI}
Measurement invariance			
1. Growth functions	.079	.976	-----
2. Plus invariance of residual variances	.073	.974	-.002
Structural invariance			
3. Plus invariance of factor means	.070	.974	0
4. Plus invariance of factor variances	.068	.973	-.001
5. Plus invariance of factor covariances	.065	.973	.000

In Model 1, the shape of growth was constrained to be equal across groups. In Model 2, the residual variances of the observed variables were further constrained to be equal across groups. This did not significantly worsen the model fit as indicated by a change in CFI equal to or less than 0.01. Overall support for invariance of the measurement model across L1 and EAL children made it possible to then test for equality of structural parameters. Next compared incrementally were the structural parameters, namely the factor means (Model 3), factor variances (Model 4), and factor covariances (Model 5). Relative to the preceding model, no significant change in CFI was found with each subsequent restriction on structural parameters. Model 5 was retained as the final unconditional model of growth in word recognition.

According to Model 5, L1 and EAL children started with similar levels of word recognition (intercept mean) and had similar rates of change over time (linear slope mean and quadratic slope mean). There were also comparable degrees of variability in the intercept variance, linear slope variance, and quadratic slope variance. The residual variances were similar across groups suggesting equality in measurement error and/or absence of un-modeled mechanism biasing the outcome for one group. The final unconditional model for word recognition yielded the following fit indices: RMSEA = .065, RMSEA 90% CI = .052 - .079, CFI = .973, $\chi^2(39) = 117.954$, $p < .001$. Figure 4.3 shows the estimated growth trajectory for L1 and EAL children in word recognition.

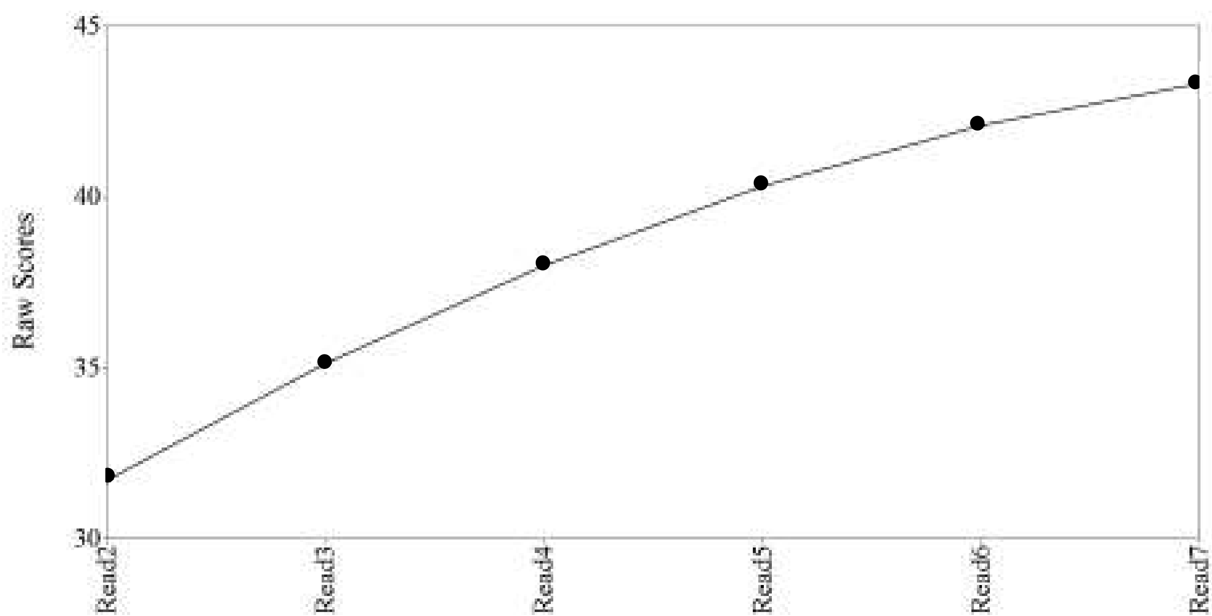

Figure 4.3. Estimated growth trajectory for word recognition.

The parameter estimates for the final unconditional model for word recognition are shown on Table 4.2. The average word recognition raw score in grade 2 was 31.71 (intercept mean), and individuals varied in their initial word recognition levels (significant intercept variance). The combination of a positive linear slope mean ($p < .05$) and a negative quadratic slope mean ($p < .05$) implies that word recognition from grades 2 to 7 is characterized by a rate of growth that slows as children grow older. Individuals also varied in the rate of linear change but not in the rate of deceleration over time (significant linear slope variance, non-significant quadratic slope variance). Given the significant amounts of unexplained variance, the next logical step was to include covariates (predictors) into the model to further explain the variation in growth factor parameter estimates.

Table 4.2

Estimates for final unconditional MG-LGM of word recognition

	Unstandardized Estimate	SE	z-value
Intercept			
Mean (Mi)	31.710	0.152	208.710*
Variance (Di)	17.387	1.114	15.604*
Slopes			
Linear mean (Ml)	3.687	0.081	45.593*
Linear variance (Dl)	1.103	0.427	2.585*
Quadratic mean (Mq)	-0.237	0.016	-17.041*
Quadratic variance (Dq)	0.027	0.015	1.855
Covariances			
Intercept with linear slope (Ril)	-1.322	.570	-2.321*
Intercept with quadratic slope (Riq)	0.037	0.099	0.373
Linear with quadratic slope (Rlq)	-0.159	0.076	-2.106*
Residual variances			
Gr. 2 Reading (E2)	4.702	0.710	6.624*
Gr. 3 Reading (E3)	8.244	0.478	17.253*
Gr. 4 Reading (E4)	5.540	0.381	14.537*
Gr. 5 Reading (E5)	8.356	0.528	15.813*
Gr. 6 Reading (E6)	6.422	0.425	15.121*
Gr. 7 Reading (E7)	7.854	0.806	9.748*

*$p < .05$ Parameter estimate is significantly different from zero

Word Recognition: Cognitive-Linguistic Predictor Model

Figure 4.4 displays the conditional growth model with three cognitive-linguistic covariates regressed on the growth factors. Predictors and their regression coefficients appear in dashed lines. This model examined how verbal working memory, syntactic awareness, and phonological processing predict individual differences in initial values and in the rates of change. It should be noted that the model assumes uniform influence of the covariates across time (i.e., time-invariant covariates). This model was fit simultaneously for L1 and EAL.

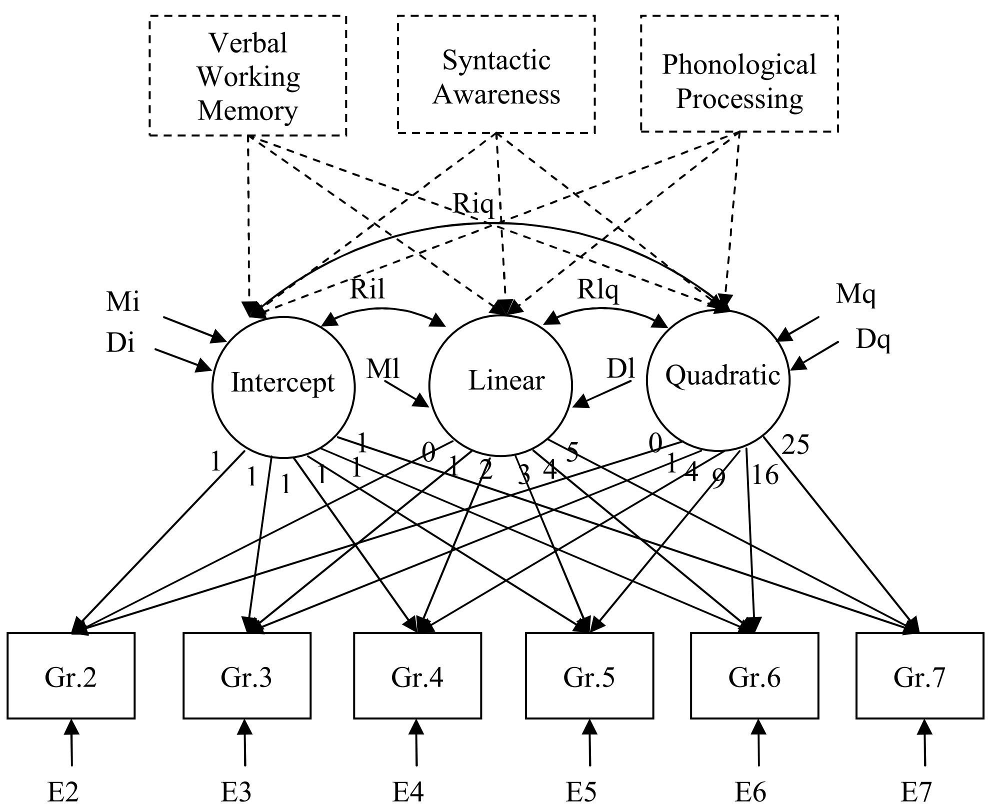

Figure 4.4. Representation of a conditional quadratic growth model.

The conditional MG-LGMs are shown in Table 4.3. Baseline Model 1 with regression coefficients freely estimated was compared to Model 2 with regression coefficients specified to be invariant across L1 and EAL groups. Imposing these restrictions did not significantly worsen model fit. That is, there were no differences across L1 and EAL children in the predictive relations between the cognitive-linguistic covariates and the growth factors. Next, a more restrictive model constraining equality of all structural parameters was tested. Again, the insignificant change in CFI provided evidence for invariance of all parameters across groups. Model 3 was retained as the final conditional MG-LGM for word recognition: RMSEA = .056, RMSEA 90% CI = .046 - .067, CFI = .971, $\chi^2(66) = 166.235$, $p < .001$.

Table 4.3

Nested models for predictor MG-LGM of word recognition

Model	RMSEA	CFI	Δ_{CFI}
Predictors (Covariates)			
1. Regression coefficients free	.058	.981	-----
2. Invariance of regression coefficients	.057	.977	-.004
3. Invariance of all parameters	.056	.971	-.006

Having established equality of regression effects, the effects can now be interpreted as such: a one-point change in the cognitive-linguistic skill is associated with a change in the growth factor by the given amount shown by the regression coefficient. The effects of the covariates are shown in Table 4.4. There was a positive effect of verbal working memory, syntactic awareness, and phonological processing on the intercept. That is, stronger cognitive-linguistic skills are related to stronger word recognition in grade 2. Together, the three cognitive-linguistic skills accounted for 46.5% of the variance in L1 word recognition (R^2 =

.465) and 51% of the variance in EAL word recognition (R^2 = .510) in initial status. In contrast, the cognitive-linguistic skills did not predict the rates of change. The only significant regression coefficient was that of phonological processing on the linear trend. Together, verbal working memory, syntactic awareness, and phonological processing did not account for a significant amount of variance in the rate of change for either L1 or EAL children ($p > .05$).

Table 4.4

Estimates for predictor MG-LGM of word recognition

	Unstandardized Estimate	SE	z-value
Effect on intercept			
Verbal working memory	0.190	0.079	2.42*
Syntactic awareness	0.596	0.071	8.427***
Phonological processing	0.364	0.021	17.375***
Effect on linear slope			
Verbal working memory	-0.043	0.052	-0.825
Syntactic awareness	-0.047	0.047	-0.991
Phonological processing	-0.036	0.014	-2.537*
Effect on quadratic slope			
Verbal working memory	0.003	0.010	0.332
Syntactic awareness	0.002	0.009	0.240
Phonological processing	0.002	0.003	0.731

$^{*}p < .05$, $^{***}p < .001$ Parameter estimate is significantly different from zero

Development of Word Reading Fluency for L1 and EAL Children

Word Reading Fluency: Unconditional Model

Due to the change in word reading fluency measures over time, repeated measures analyses were only available for grades 3 through 6. The best fitting growth shape to the word reading fluency data was piecewise. In other words, development is characterized by more than one growth period. An examination of individual trajectories and plotted means of each group (Figure 4.5) showed two possible linear growth periods (grade 3 to 5, grade 5 to 6).

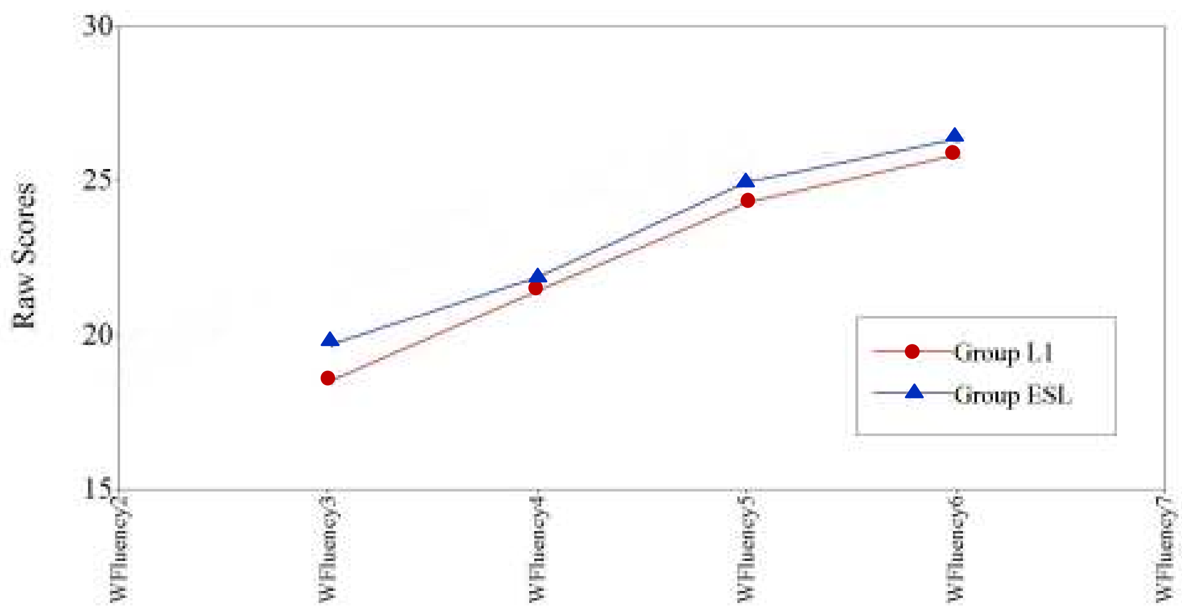

Figure 4.5. Plot of observed group means for word reading fluency.

In a piecewise model, three growth factors are estimated: the intercept (initial level), linear slope 1, and linear slope 2. The intercept growth factor is fixed at 1. Slope 1 describes the constant rate of change across the first period (grades 3 through 5). Thus, the factor loadings for linear slope 1 were specified to be 0, 1, 2, 2. The second slope factor captures the second growth period. The factor loadings for linear slope 2 were 0, 0, 0, 1. Because there were only two time points in slope 2, not all parameters could be identified. Thus the variance of slope 2 was fixed at zero to allow model specification. This also effectively resulted in covariance estimates with slope 2 at zero. Figure 4.6 shows the unconditional piecewise growth model for word reading fluency.

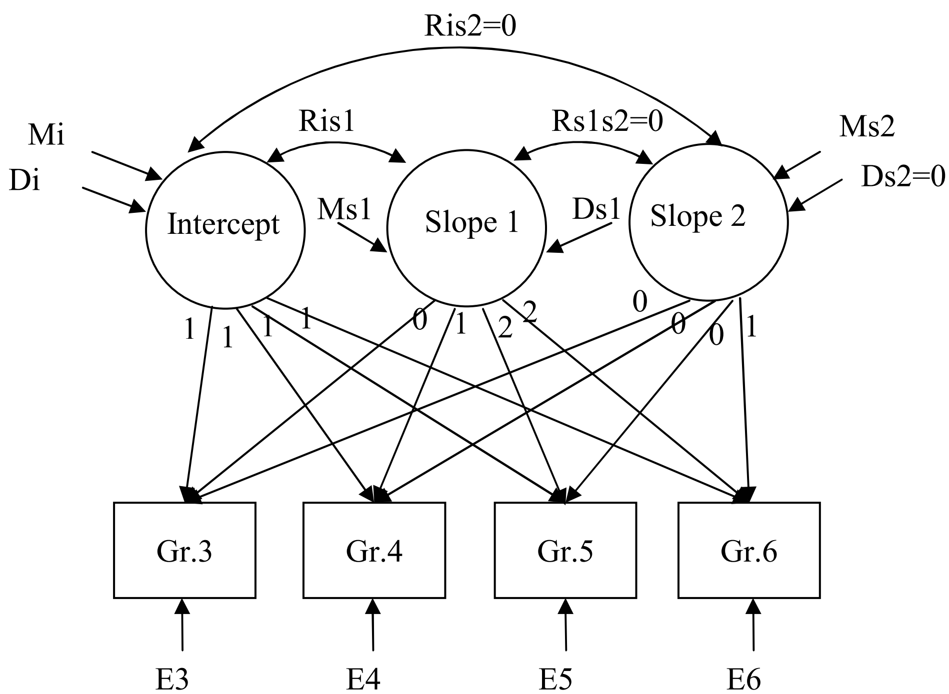

Figure 4.6. Representation of an unconditional piecewise growth model for word fluency.

The L1 model was a good fit to the data: RMSEA = .043, RMSEA 90% CI = .006 - .079, CFI = .996, $\chi^2(4) = 9.793$; $p < .05$. The fit for the EAL model was also good: RMSEA = .000, RMSEA 90% CI = 0 - .111, CFI = 1.000, $\chi^2(4) = 3.918$, p = ns. A series of MG-LGM was then used to test equality of model parameters across L1 and EAL children. In a stepwise fashion, model parameters were constrained to be equal across L1 and EAL groups. In testing measurement and structural invariance, each subsequent model did not significantly worsen model fit as indicated by changes in CFI equal to or less than 0.01. The results of the invariance testing showed that L1 and EAL children were the same in all respects in their unconditional model of word reading fluency development. The results are summarized in Table 4.5. The strictest model, Model 5, was retained as the final unconditional model of growth in word reading fluency. Model 5 yielded the following indices indicating good fit to the data: RMSEA = .045, RMSEA 90% CI = .023 - .067, CFI = .990, $\chi^2(18) = 35.723$, $p < .01$. The estimated growth trajectory for word reading fluency is shown in Figure 4.7.

Table 4.5

Nested models for unconditional MG-LGM of word reading fluency

Model	RMSEA	CFI	Δ_{CFI}
Measurement invariance			
1. Growth functions	.039	.997	-----
2. Plus invariance of residual variances	.031	.997	0
Structural invariance			
3. Plus invariance of factor means	.037	.995	.002
4. Plus invariance of factor variances	.040	.993	.002
5. Plus invariance of factor covariances	.045	.990	.003

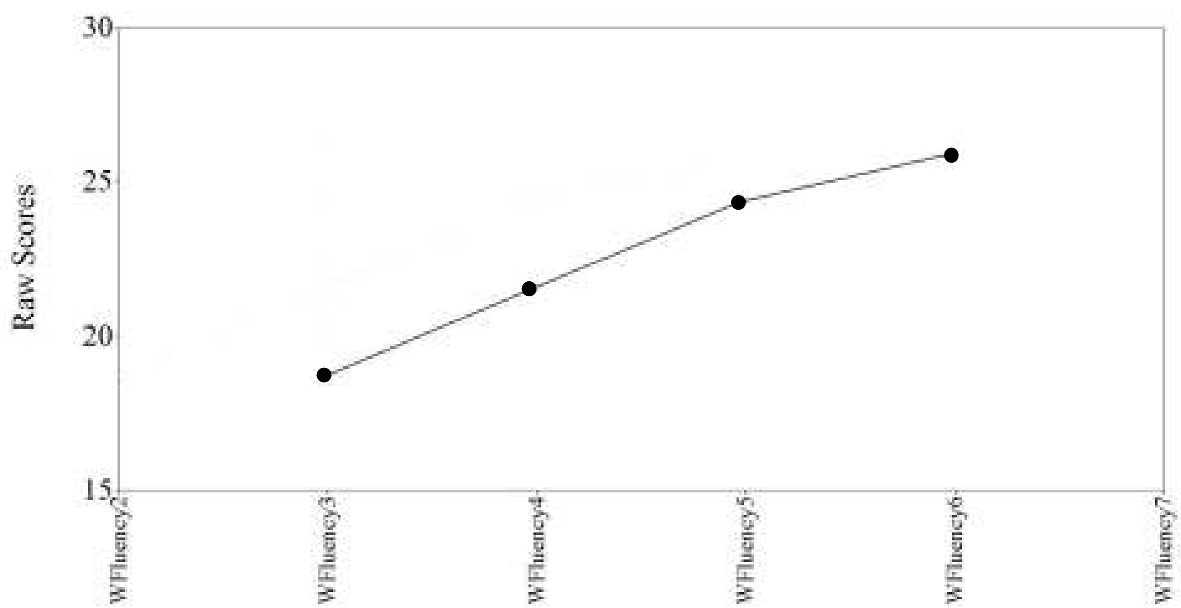

Figure 4.7. Estimated growth trajectory for word reading fluency.

Shown on Table 4.6 are the parameter estimates for word reading fluency Model 5 (final unconditional model). On average, the children read 18.69 words per minute in grades 2, but there was variation around that score. There was no significant relationship in initial status and rate of change in the first growth period. Individual children varied in their rates of change in both growth periods. On average, word reading fluency increased by 2.85 words per minute each year from grades 3 through 5 and 1.53 words per minute from grades 5 to 6.

Table 4.6

Estimates for final unconditional MG-LGM of word reading fluency

	Unstandardized Estimate	SE	z-value
Intercept			
Mean (Mi)	18.690	0.154	120.980***
Variance (Di)	17.588	1.150	15.288***
Slopes			
Slope 1 mean (Ms1)	2.845	.072	39.408***
Slope 1 variance (Ds1)	.965	.276	3.493***
Slope 2 mean (Ms2)	1.532	.143	10.688***
Slope 2 variance (Ds2)	----	----	----
Covariances			
Intercept with slope 1 (Ris1)	-.681	.456	0.135
Intercept with slope 2 (Ris2)	----	----	----
Slope 1 with slope 2 (Rs1s2)	----	----	----
Residual variances			
Gr. 3 WFluency (E3)	5.739	.741	7.743***
Gr. 4 WFluency (E4)	6.167	.430	14.350***
Gr. 5 WFluency (E5)	7.153	.580	12.324***
Gr. 6 WFluency (E6)	9.658	.675	14.306***

***$p < .001$ Parameter estimate is significantly different from zero

Variance and covariances with slope 2 were not estimated

Word Reading Fluency: Cognitive-Linguistic Predictor Model

The conditional growth model for word reading fluency is as shown on Figure 4.6 but with the addition of each covariate regressed on each growth factor. This model was fit simultaneously for L1 and EAL in a MG-LGM. There were no differences across L1 and EAL children in the predictive relations between the cognitive-linguistic covariates and the growth factors. The nested model testing is summarized in Table 4.7. Model 3, specifying equality of all parameters, was retained as the final conditional MG-LGM for word reading fluency: RMSEA = .047, RMSEA 90% CI = .031 - .063, CFI = .984, $\chi^2(33) = 68.320$, $p < .001$.

Table 4.7

Nested models for predictor MG-LGM of word reading fluency

Model	RMSEA	CFI	Δ_{CFI}
Predictors (Covariates)			
1. Regression coefficients free	0	1.00	-----
2. Invariance of regression coefficients	.034	.994	-.006
3. Invariance of all parameters	.047	.984	-.01

The parameter estimates for predictor model are shown in Table 4.8. The cognitive-linguistic skills were positive predictors of children's word reading fluency at initial status (intercept). Together, the three cognitive-linguistic skills accounted for 33.2% of the variance in L1 word reading fluency (R^2 = .332) and 37.3% of the variance in EAL word reading fluency (R^2 = .373). In contrast, the cognitive-linguistic skills were not significant predictors of rates of change for either the first or second growth periods.

Table 4.8

Estimates for predictor MG-LGM of word reading fluency

	Unstandardized Estimate	SE	z-value
Effect on intercept			
Verbal working memory	.214	.088	2.417*
Syntactic awareness	.490	.080	6.151***
Phonological processing	.303	.024	12.798***
Effect on slope 1			
Verbal working memory	.033	.048	.680
Syntactic awareness	.039	.043	.896
Phonological processing	-.006	.013	-.486
Effect on slope 2			
Verbal working memory	-.103	.096	-1.073
Syntactic awareness	-.066	.086	-.768
Phonological processing	-.023	.026	-.876

*$p < .05$, ***$p < .001$ Parameter estimate is significantly different from zero

Development of Decoding for L1 and EAL Children

Decoding: Unconditional Model

The best fitting growth shape to the decoding data was piecewise. In other words, there was not a constant rate of change over time but two linear periods with different rates of change. In fact, examination of individual trajectories and plotted means of each group show a period of positive growth followed by a plateau. The observed W score means for each group are plotted in Figure 4.8.

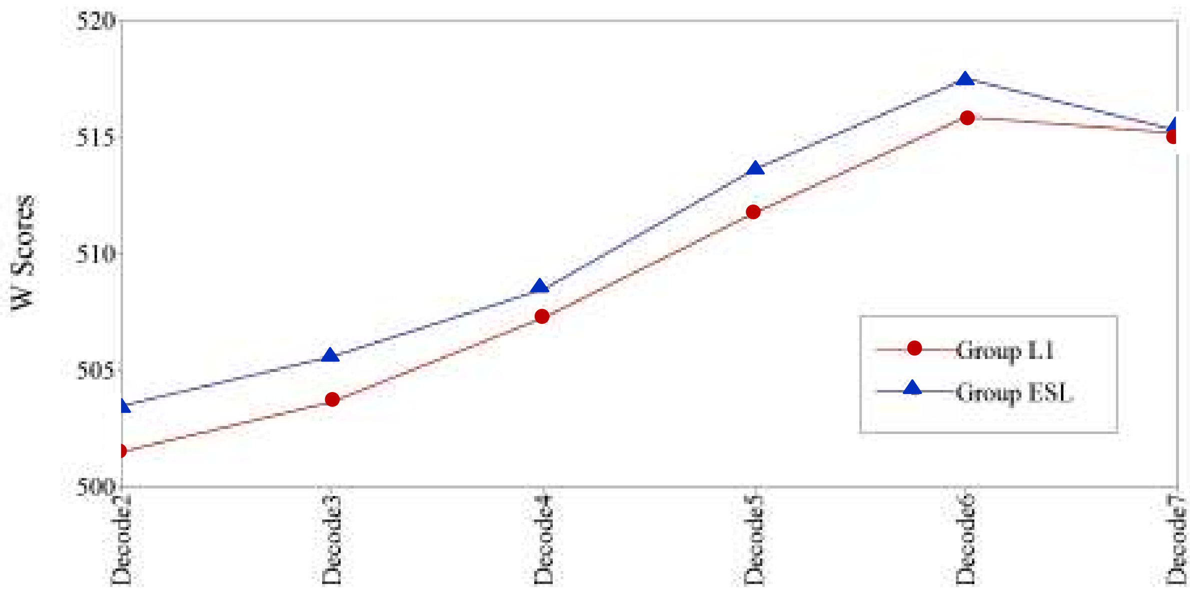

Figure 4.8. Plot of observed group means for decoding.

In the piecewise model for decoding, slope 1 describes the constant rate of change across the first period (grades 2 through 6). Thus, the factor loadings for linear slope 1 were specified to be 0, 1, 2, 3, 4, 4. The second slope factor captures the plateau subsequent to what is predicted by the first linear slope. The factor loadings for linear slope 2 were 0, 0, 0, 0, 0, 1. Because there were only two time points in slope 2, not all parameters could be identified. Thus the variance of slope 2 was fixed at zero to allow model specification. This also effectively resulted in covariance estimates with slope 2 at zero. Figure 4.9 shows the unconditional piecewise growth model.

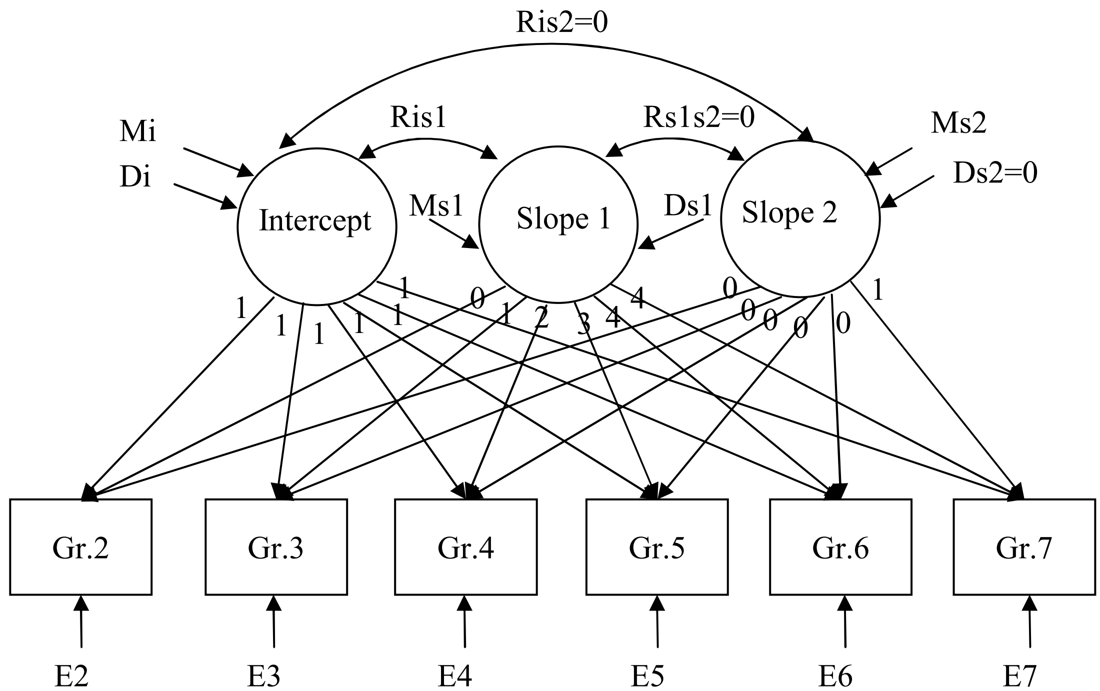

Figure 4.9. Representation of an unconditional piecewise growth model for decoding.

Models were initially fit separately for L1 and EAL children. Fit indices for each group indicate adequate model fit for L1: RMSEA = .059, RMSEA 90% CI = .045 - .078, CFI = .985, $\chi^2(15) = 58.587$, $p < .001$. The model fit was also adequate for EAL: RMSEA = .077, RMSEA 90% CI = .037 - .118, CFI = .972, $\chi^2(15) = 30.979$, $p < .01$. Then a series of MG-LGMs were used to test invariance across parameters. The results are summarized in Table 4.9. Model 5, the strictest model with all measurement and structural parameters constrained to be equal, was retained as the final unconditional model of growth in decoding. Model 5 yielded the following indices indicating good fit to the data: RMSEA = .055, RMSEA 90% CI = .042 - .069, CFI = .983, $\chi^2(42) = 102.864$, $p < .001$.

Table 4.9

Nested models for unconditional MG-LGM of decoding

Model	RMSEA	CFI	Δ_{CFI}
Measurement invariance			
1. Growth functions	.064	.983	-----
2. Plus invariance of residual variances	.057	.984	.001
Structural invariance			
3. Plus invariance of factor means	.057	.983	-.001
4. Plus invariance of factor variances	.055	.983	0
5. Plus invariance of factor covariances	.055	.983	0

Shown on Table 4.10 are the parameter estimates for decoding Model 5 (final unconditional model). The average Word Attack W score was 501.23, but individuals varied as to their initial score. A significant positive slope 1 coupled with an insignificant slope 2 characterizes growth that is constant from grades 2 through 6 and then levels off at grade 6. Individual children varied in their rate of change from grades 2 through 6 (significant slope 1 variance), but on average the children grew by 3.59 W score points per year. Also, children with a lower start showed a higher rate of growth through to grade 6, and children with a higher start showed a lower rate of change (negative covariance). The estimated growth trajectory for decoding is shown in Figure 4.10.

Table 4.10

Estimates for final unconditional MG-LGM of decoding

	Unstandardized Estimate	SE	z-value
Intercept			
Mean (Mi)	501.232	.434	1155.632***
Variance (Di)	151.993	8.153	18.643***
Slopes			
Slope 1 mean (Ms1)	3.591	.085	42.368***
Slope 1 variance (Ds1)	1.561	.292	5.340***
Slope 2 mean (Ms2)	-.371	.345	-1.075
Slope 2 variance (Ds2)	----	----	----
Covariances			
Intercept with slope 1 (Ris1)	-8.550	1.218	-7.020***
Intercept with slope 2 (Ris2)	----	----	----
Slope 1 with slope 2 (Rs1s2)	----	----	----
Residual variances			
Gr. 2 Decoding (E2)	37.723	3.152	11.967***
Gr. 3 Decoding (E3)	51.902	3.062	16.951***
Gr. 4 Decoding (E4)	46.599	2.731	17.062***
Gr. 5 Decoding (E5)	62.570	3.756	16.659***
Gr. 6 Decoding (E6)	43.122	3.038	14.194***
Gr. 7 Decoding (E7)	53.042	3.645	14.554***

****p* < . 001 Parameter estimate is significantly different from zero

Variance and covariances with slope 2 were not estimated

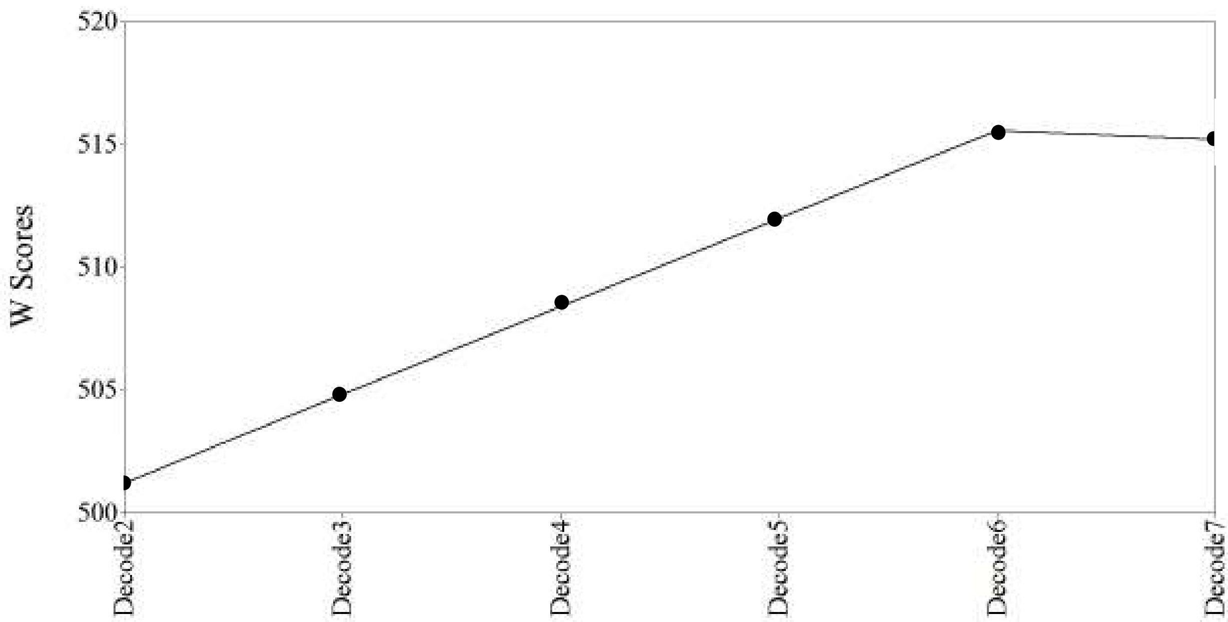

Figure 4.10. Estimated growth trajectory for decoding.

Decoding: Cognitive-Linguistic Predictor Model

The conditional growth model for decoding is as shown on Figure 4.9 but with the addition of each covariate regressed on each growth factor. The nested MG-LGM testing is summarized in Table 4.11.

Table 4.11

Nested models for predictor MG-LGM of decoding

Model	RMSEA	CFI	Δ_{CFI}
Predictors (Covariates)			
1. Regression coefficients free	.050	.986	-----
2. Invariance of regression coefficients	.049	.984	-.002
3. Invariance of all parameters	.048	.981	-.003

Model 3, specifying equality of all parameters, was retained as the final conditional MG-LGM for decoding: RMSEA = .048, RMSEA 90% CI = .037 - .058, CFI = .981, $\chi^2(69)$ = 143.416, $p < .001$. There were no differences across L1 and EAL children in the predictive relations between the cognitive-linguistic covariates and the growth factors.

The parameter estimates for the model are shown in Table 4.12. Verbal working memory did not emerge as a significant predictor. Syntactic awareness and phonological processing were positive predictors of children's decoding performance at the initial level (intercept). Syntactic awareness and phonological processing were also significant predictors of slope 1. The relationship was in the negative direction suggesting that children with lower syntactic awareness and lower phonological processing showed steeper growth over the first time period.

Table 4.12

Estimates for predictor MG-LGM of decoding

	Unstandardized Estimate	SE	z-value
Effect on intercept			
Verbal working memory	.305	.228	1.340
Syntactic awareness	1.250	.205	6.102***
Phonological processing	1.133	.061	18.671***
Effect on slope 1			
Verbal working memory	.020	.054	.361
Syntactic awareness	-.147	.049	-3.008**
Phonological processing	-.066	.015	-4.527***
Effect on slope 2			
Verbal working memory	-.141	.228	-.617
Syntactic awareness	.184	.207	.887
Phonological processing	-.063	.062	-1.005

**$p < .01$, ***$p < .001$ Parameter estimate is significantly different from zero

None of the cognitive-linguistic skills predicted the plateau of slope 2. For L1 children, the predictors accounted for 42.5% of the variance in decoding at the initial level and 17.4% of the variance in the slope 1. For EAL children, the predictors accounted for 46.2% of the variance in decoding at the initial level and 20.3% of the variance in slope 1. Since slope 2 variance was fixed at zero for purposes of model identification, there was no variance to explain.

Development of Decoding Fluency for L1 and EAL Children

Decoding Fluency: Unconditional Model

Due to the change in measures over time, repeated measures analyses was only available for grades 2 through 6. The observed scores for each group are plotted in Figure 4.11. An examination of individual trajectories and plotted means of each group showed two possible growth periods. The best fitting growth shape to the decoding fluency data was piecewise.

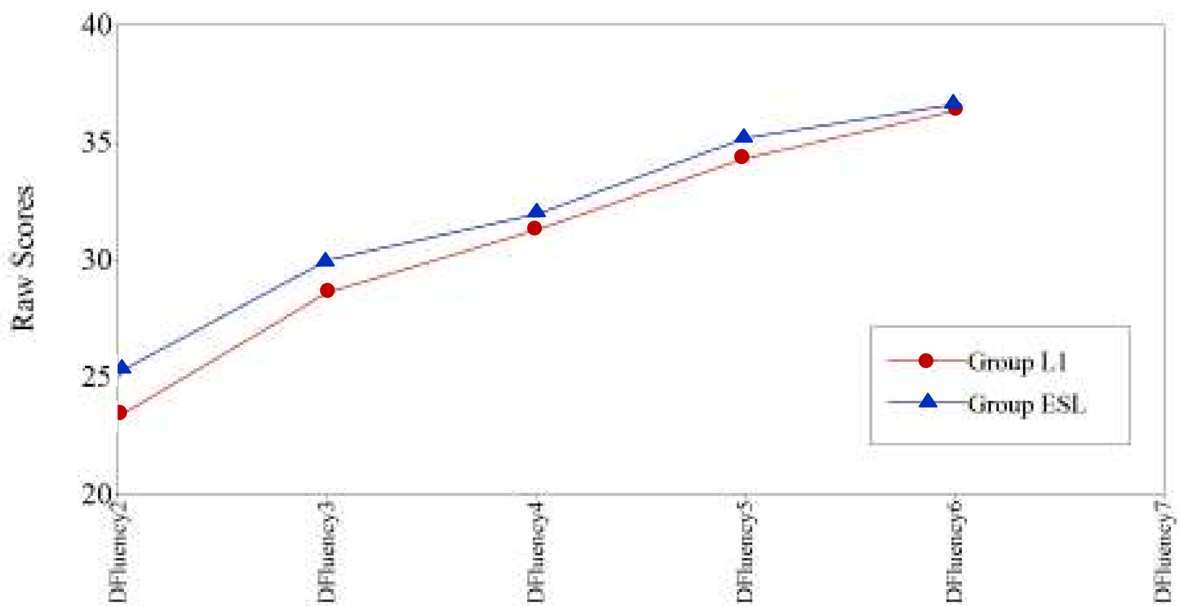

Figure 4.11. Plot of observed group means for decoding fluency.

In the piecewise model for decoding fluency, slope 1 describes the rate of change across the first period (grades 2 to 3). Thus, the factor loadings for linear slope 1 were specified to be 0, 1, 1, 1, 1. Because there were only two time points in slope 1, not all parameters could be identified. Thus the variance of slope 1 was fixed at zero to allow model specification. This also effectively resulted in covariance estimates with slope 1 at zero. The second slope factor captures the growth from grades 3 to 6. The factor loadings for linear slope 2 were 0, 0, 1, 2, 3. Figure 4.12 shows the unconditional piecewise growth model.

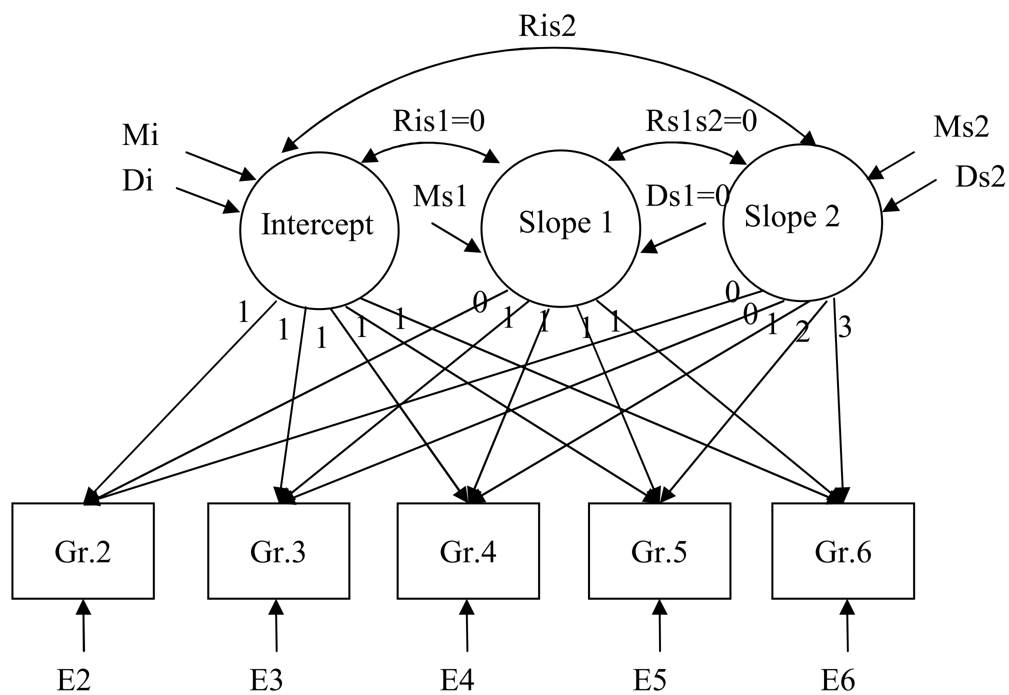

Figure 4.12. Representation of unconditional piecewise growth model for decoding fluency.

Models were initially fit separately for L1 and EAL children. Fit indices indicate adequate fit for L1: RMSEA = .070, RMSEA 90% CI = .050 - .092, CFI = .986, $\chi^2(9) = 43.416$, $p < .001$. The model fit was mediocre for EAL: RMSEA = .086, RMSEA 90% CI = .038 - .134, CFI = .972, $\chi^2(9) = 21.010$, $p < .05$. The results of the invariance testing showed that L1 and EAL children were the same in all respects in their unconditional model of decoding fluency.

The results are summarized in Table 4.13. The strictest model, Model 5, was retained as the final unconditional model of growth in decoding fluency. Model 5 yielded the following indices indicating adequate fit to the data: RMSEA = .062, RMSEA 90% CI = .047 - .078, CFI = .982, $\chi^2(29) = 82.487$, $p < .001$. The estimated growth trajectory for decoding fluency is shown in Figure 4.13.

Table 4.13

Nested models for unconditional MG-LGM of decoding fluency

Model	RMSEA	CFI	Δ_{CFI}
Measurement invariance			
1. Growth functions	.073	.984	-----
2. Plus invariance of residual variances	.065	.984	0
Structural invariance			
3. Plus invariance of factor means	.064	.983	-.001
4. Plus invariance of factor variances	.063	.982	-.001
5. Plus invariance of factor covariances	.062	.982	0

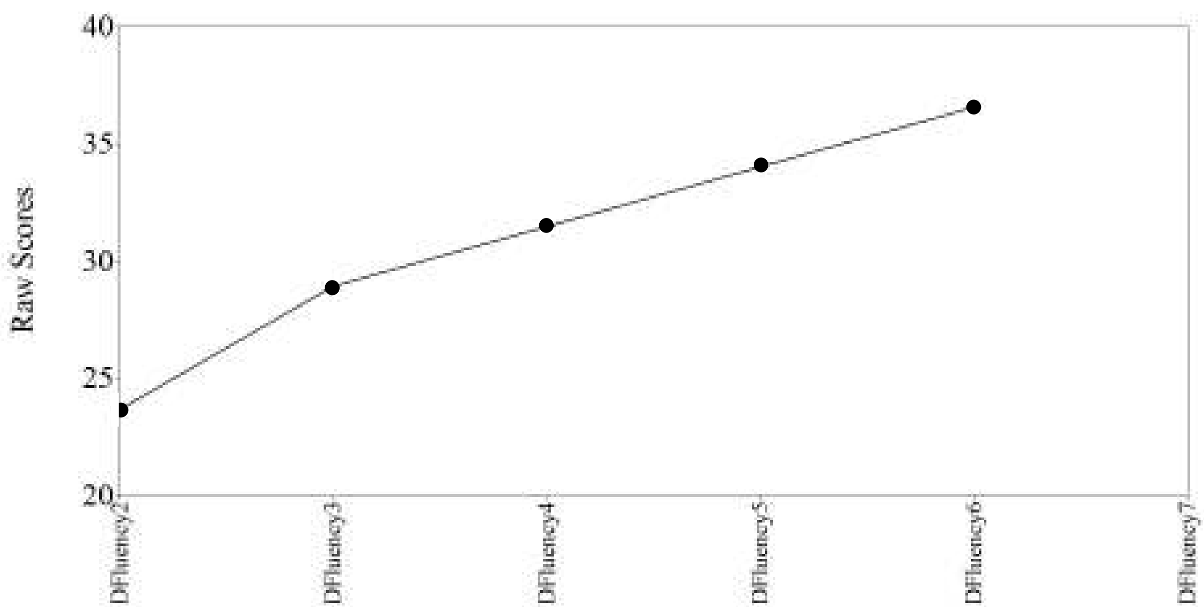

Figure 4.13. Estimated growth trajectory for decoding fluency.

Shown on Table 4.14 are the parameter estimates for Model 5 (final unconditional model). On average, the children read 23.67 pseudowords per minute in grade 2, but there was individual variation around that score. During the first growth period, decoding fluency increased by 5.27 pseudowords from grades 2 to 3. During the second growth period, decoding fluency increased by 2.54 pseudowords per year from grades 3 to 6.

Table 4.14

Estimates for final unconditional MG-LGM of decoding fluency

	Unstandardized Estimate	SE	z-value
Intercept			
Mean (Mi)	23.674	.290	81.711***
Variance (Di)	55.264	2.887	19.145***
Slopes			
Slope 1 mean (Ms1)	5.267	.192	27.367***
Slope 1 variance (Ds1)	----	----	----
Slope 2 mean (Ms2)	2.542	.068	37.271***
Slope 2 variance (Ds2)	1.711	.200	8.558***
Covariances			
Intercept with slope 1 (Ris1)	----	----	----
Intercept with slope 2 (Ris2)	-8.599	.648	-13.262***
Slope 1 with slope 2 (Rs1s2)	----	----	----
Residual variances			
Gr. 2 DFluency (E2)	24.767	1.447	17.112***
Gr. 3 DFluency (E3)	15.949	1.117	14.276***
Gr. 4 DFluency (E4)	10.953	.731	14.985***
Gr. 5 DFluency (E5)	12.413	.788	15.743***
Gr. 6 DFluency (E6)	8.346	.845	9.877***

***$p < .001$ Parameter estimate is significantly different from zero

Variance and covariances with slope 2 were not estimated

Decoding Fluency: Cognitive-Linguistic Predictor Model

The conditional growth model for decoding fluency is as shown on Figure 4.12 but with the addition of each covariate regressed on each growth factor. The nested MG-LGM testing is summarized in Table 4.15.

Table 4.15

Nested models for predictor MG-LGM of decoding fluency

Model	RMSEA	CFI	Δ_{CFI}
Predictors (Covariates)			
1. Regression coefficients free	.049	.990	-----
2. Invariance of regression coefficients	.047	.988	-.002
3. Invariance of all parameters	.049	.983	-.005

Model 3, specifying equality of all parameters, was retained as the final conditional MG-LGM for decoding fluency: RMSEA = .049, RMSEA 90% CI = .037 - .062, CFI = .983, $\chi^2(50) = 108.046$, $p < .001$. There were no differences across L1 and EAL children in the predictive relations between the cognitive-linguistic covariates and the growth factors.

The parameter estimates for the predictor model are shown in Table 4.16. Syntactic awareness, verbal working memory, and phonological processing were significant predictors of initial status. Children who had stronger cognitive linguistic skills also had stronger decoding fluency. Only phonological processing predicted slope 1. There was a negative relationship suggesting that children with lower phonological processing showed steeper growth from grades 2 to 3. Phonological processing and syntactic awareness predicted slope 2. Again, the relationship was in the negative direction, suggesting that children who were lower in these skills showed the steepest growth from grades 3 through 6. For L1 children, the predictors accounted for 46% of the variance in decoding fluency at initial status and 24% of the variance in slope 2. For EAL children, the predictors accounted for 49.7% of the variance in decoding fluency at initial status and 27.6% of the variance in slope 2. Since slope 1 variance was fixed at zero for purposes of model identification, there was no variance to explain.

Table 4.16

Estimates for predictor MG-LGM of decoding fluency

	Unstandardized Estimate	SE	z-value
Effect on intercept			
Verbal working memory	.432	.163	2.656***
Syntactic awareness	.679	.146	4.657***
Phonological processing	.777	.043	17.970***
Effect on slope 1			
Verbal working memory	-.124	.123	-1.005
Syntactic awareness	.012	.111	.110
Phonological processing	-.219	.033	-6.660***
Effect on slope 2			
Verbal working memory	-.075	.042	-1.757
Syntactic awareness	-.120	.038	-3.109**
Phonological processing	-.075	.011	-6.613***

**$p < .01$, ***$p < .001$ Parameter estimate is significantly different from zero

Development of Reading Comprehension L1 and EAL Children

Reading Comprehension: Unconditional Model

The best fitting model to the reading comprehension data was linear. Figure 4.14 shows the unconditional linear growth model for reading comprehension. In a linear model, the intercept and only one slope are estimated. The intercept growth factor is fixed at 1. The linear slope describes the constant rate of change across time. Thus, the factor loadings for the slope were specified to be 0, 1, 2, 3, 4, 5. Models were initially fit separately for L1 and EAL children. Fit indices for each group indicate adequate model fit for L1: RMSEA = .077, RMSEA 90% CI = .062 - .093, CFI = .967, $\chi^2(16) = 89.265$, $p < .001$. The model fit was also adequate for EAL: RMSEA = .088, RMSEA 90% CI = .052 - .124, CFI = .953, $\chi^2(16) = 38.352$, $p < .01$. The observed standard score means for each group are plotted in Figure 4.15.

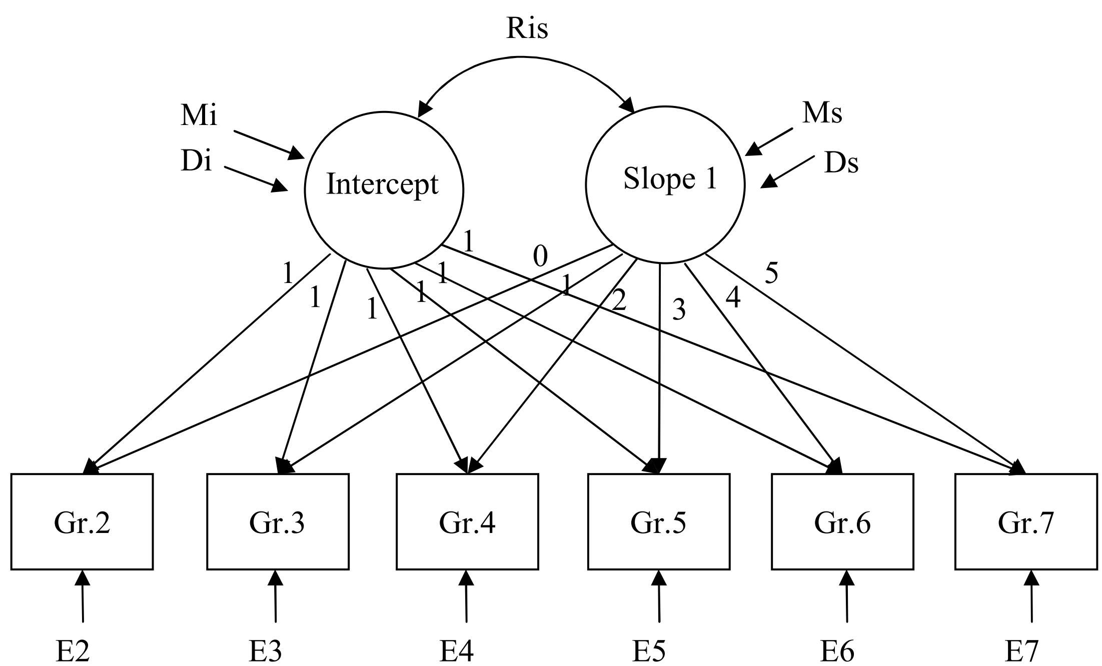

Figure 4.14. Representation of an unconditional linear growth model for reading comprehension.

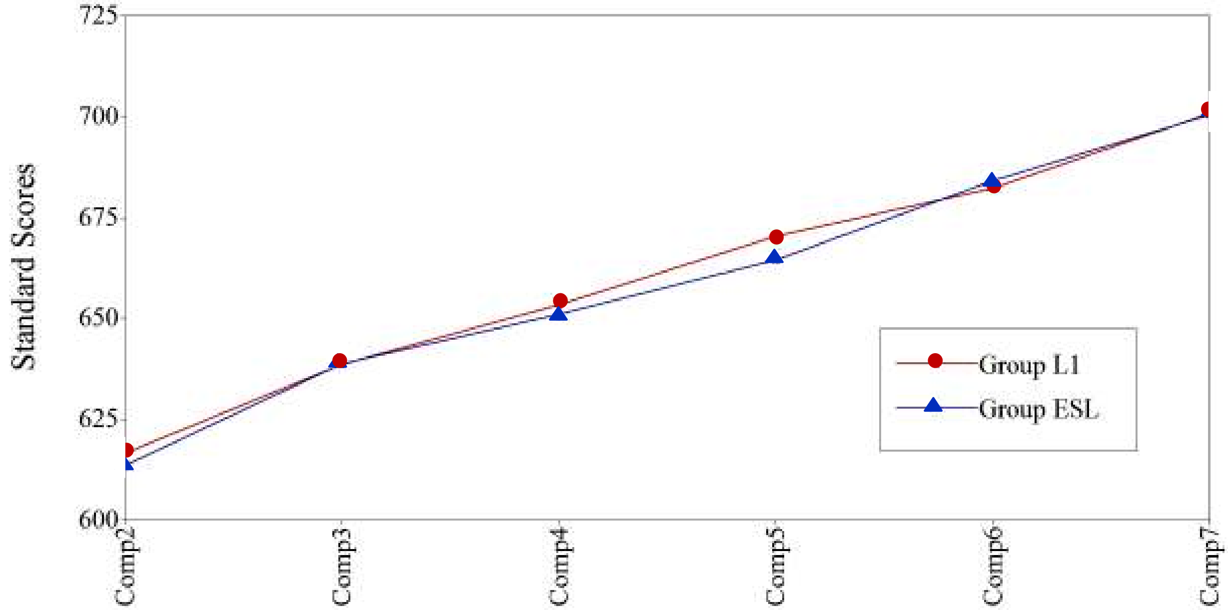

Figure 4.15. Plot of observed group means for reading comprehension.

The results of the MG-LGM invariance testing are summarized in Table 4.17. Model 5, the strictest model with all measurement and structural parameters constrained to be equal, was retained as the final unconditional model for reading comprehension. Model 5 yielded the following indices indicating adequate fit to the data: RMSEA = .068, RMSEA 90% CI = .055 - .081, CFI = .965, $\chi^2(43) = 137.768$, $p < .001$.

Table 4.17

Nested models for unconditional MG-LGM of reading comprehension

Model	RMSEA	CFI	Δ_{CFI}
Measurement invariance			
1. Growth functions	.079	.965	----
2. Plus invariance of residual variances	.073	.964	-.001
Structural invariance			
3. Plus invariance of factor means	.071	.965	.001
4. Plus invariance of factor variances	.069	.965	0
5. Plus invariance of factor covariances	.068	.965	0

Shown on Table 4.18 are the parameter estimates for reading comprehension Model 5 (final unconditional model). Children varied in their initial reading comprehension levels (intercept variance) and in their rates of change (slope variance). The average reading comprehension standard score in grade 2 was 620.04 (intercept mean) and the average growth each year was by 16.13 standard score points (slope mean). Surprisingly, the covariance was not significant suggesting that where they started was not related to how they grew over time. Figure 4.16 shows the estimated growth trajectory for reading comprehension.

Table 4.18

Estimates for final unconditional MG-LGM of reading comprehension

	Unstandardized Estimate	SE	z-value
Intercept			
Mean (Mi)	620.042	1.112	557.418***
Variance (Di)	796.129	55.681	14.298****
Slope			
Mean (Ms)	16.131	.252	64.021***
Variance (Ds)	14.233	2.966	4.798***
Covariance			
Intercept with slope (Ris)	-5.170	10.081	-.513
Residual variances			
Gr. 2 Comprehension (E2)	928.015	53.633	17.303***
Gr. 3 Comprehension (E3)	613.614	35.543	17.264***
Gr. 4 Comprehension (E4)	312.063	20.398	15.298***
Gr. 5 Comprehension (E5)	393.620	25.972	15.156***
Gr. 6 Comprehension (E6)	390.005	27.509	14.177***
Gr. 7 Comprehension (E7)	496.527	40.499	12.260***

***p < . 001 Parameter estimate is significantly different from zero

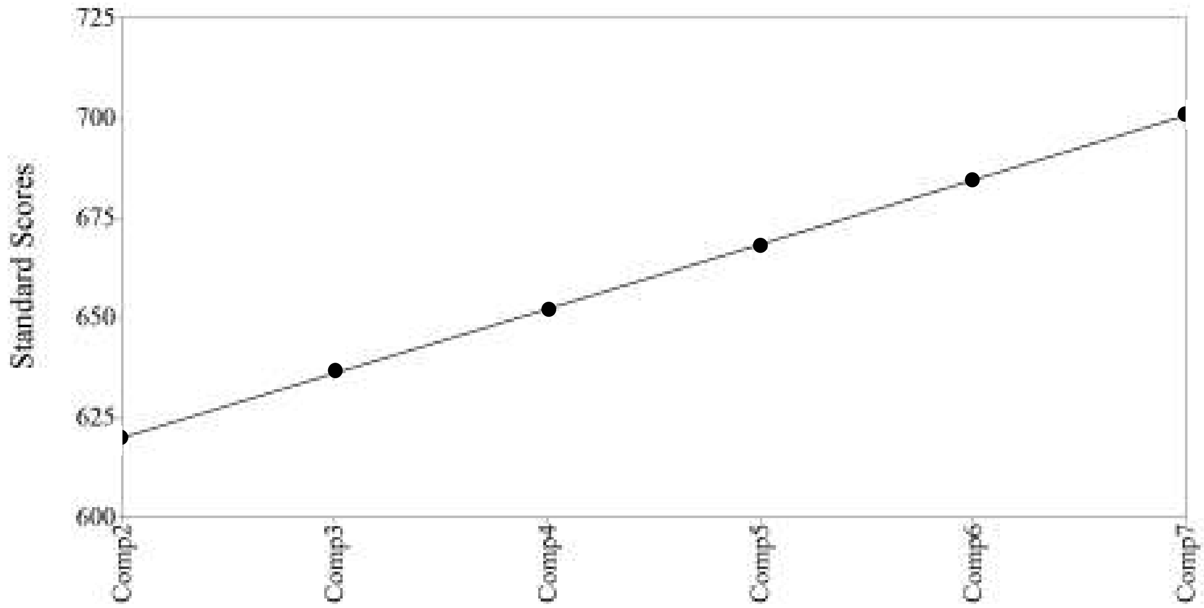

Figure 4.16. Estimated growth trajectory for reading comprehension.

Reading Comprehension: Cognitive-Linguistic Predictor Model

The conditional growth model for reading comprehension is as shown on Figure 4.14 but with the addition of each covariate regressed on the intercept and slope growth factors. The nested MG-LGM testing is summarized in Table 4.19. Model 3, specifying equality of all parameters, was retained as the final conditional MG-LGM. The fit indices are as follows: RMSEA = .065, RMSEA 90% CI = .055 - .075, CFI = .953, $\chi^2(73) = 221.060$, $p < .001$.

Table 4.19

Nested models for predictor MG-LGM of reading comprehension

Model	RMSEA	CFI	Δ_{CFI}
Predictors (Covariates)			
1. Regression coefficients free	.064	.966	----
2. Invariance of regression coefficients	.069	.956	-.01
3. Invariance of all parameters	.065	.953	-.003

The estimates for the predictor model are shown in Table 4.20. Verbal working memory, syntactic awareness, and phonological processing were positive predictors of children's reading comprehension at the initial level (intercept). The predictors accounted for 41.8% of the variance in reading comprehension at the initial level for L1 and 48.9% of the variance for EAL. In contrast, none of the cognitive-linguistic skills were significant predictors of growth over time nor did they account for a significant amount of variance in the slope for either L1 or EAL.

Table 4.20

Estimates for predictor MG-LGM of reading comprehension

	Unstandardized Estimate	SE	z-value
Effect on intercept			
Verbal working memory	4.074	.620	6.567***
Syntactic awareness	6.718	.559	12.023***
Phonological processing	1.063	.166	6.408***
Effect on slope			
Verbal working memory	.132	.167	.789
Syntactic awareness	-.123	.150	-.819
Phonological processing	-.010	.045	-.214

***p < .001 Parameter estimate is significantly different from zero

Development of Spelling for L1 and EAL Children

Spelling: Unconditional Model

Similar to word recognition, the best fitting model to the spelling data was quadratic in form (refer back to Figure 4.2 for diagram of quadratic growth model). The observed raw score means are plotted in Figure 4.17. The L1 baseline model was a good fit to the data: RMSEA = .024, RMSEA 90% CI = 0 - .047, CFI = .999, $\chi^2(12) = 17.377$; p = ns. The fit indices for the EAL model were also good: RMSEA = .062, RMSEA 90% CI = 0 - .107, CFI = .989, $\chi^2(12) = 20.312$, p = ns.

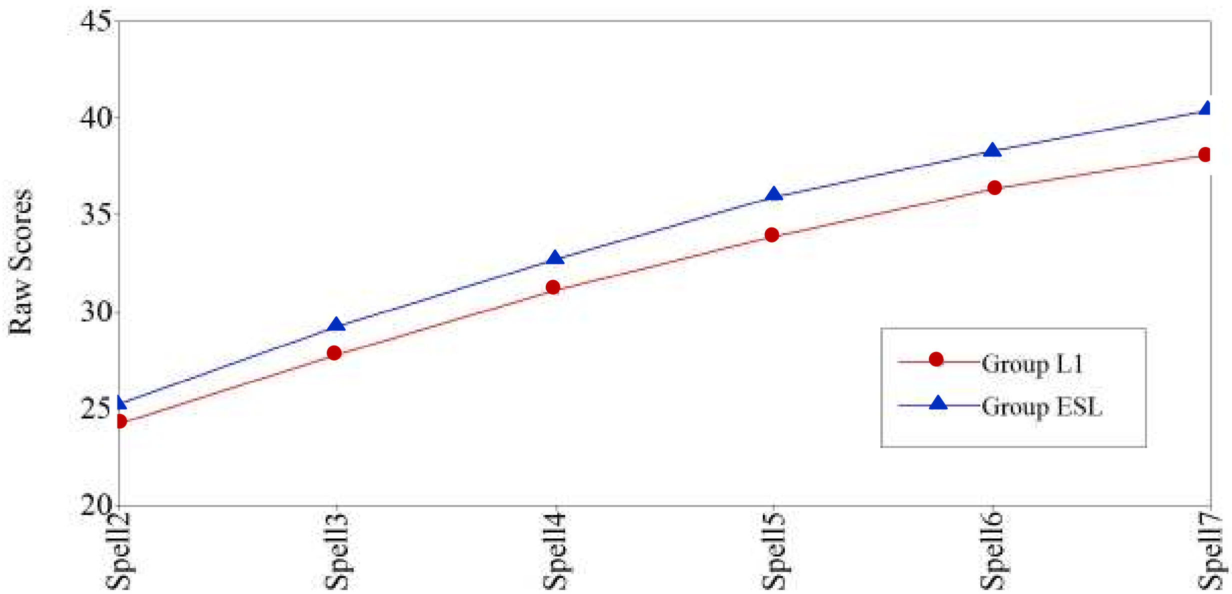

Figure 4.17. Plot of observed group means for spelling.

A series of MG-LGM was then used to test equality of model parameters across L1 and EAL children. In a stepwise fashion, model parameters were constrained to be equal across L1 and EAL groups. The results are summarized in Table 4.21. In testing measurement and structural invariance, each subsequent model did not significantly worsen model fit as indicated by changes in CFI of less than .01. The results of the invariance testing showed that L1 and

EAL children were the same in all respects in their unconditional model of spelling development. They did not differ in the shape of growth, the initial level in grade 2 (intercept mean), or the rates of change (linear slope mean and quadratic slope mean). Intercept variance, linear slope variance, quadratic slope variance, and residual variances were all equal across L1 and EAL children. The strictest model, Model 5, was retained as the final unconditional model of growth in spelling. Model 5 yielded the following indices indicating good fit to the data: RMSEA = .047, RMSEA 90% CI = .033 - .062, CFI = .991, $\chi^2(39) = 80.913$, $p < .001$.

Table 4.21

Nested models for unconditional MG-LGM of spelling

Model	RMSEA	CFI	Δ_{CFI}
Measurement invariance			
1. Growth functions	.035	.997	-----
2. Plus invariance of residual variances	.029	.997	0
Structural invariance			
3. Plus invariance of factor means	.052	.991	-.006
4. Plus invariance of factor variances	.049	.991	0
5. Plus invariance of factor covariances	.047	.991	0

Shown on Table 4.22 are the parameter estimates for spelling Model 5 (final unconditional model). Significant linear slope and quadratic slope means indicate that children's spelling development from grades 2 to 7 is curvilinear with deceleration in the rate of change over time. There was also significant individual variation in spelling skill at the initial level (intercept variance) and in the rates of change (slope variance and quadratic variance). The covariance between the intercept factor and linear slope factor was positive, and the covariance between the intercept and quadratic slope factor was negative. That is, children with a better start showed more positive growth in the linear slope but more negative deceleration in the quadratic slope. On the other hand, children with a lower start showed a slower rate of linear growth but a less negative rate of deceleration. The estimated growth trajectory for spelling is shown in Figure 4.18.

Table 4.22

Estimates for final unconditional MG-LGM of spelling

	Unstandardized Estimate	SE	z-value
Intercept			
Mean (Mi)	24.392	.103	237.741***
Variance (Di)	8.487	.522	16.246***
Slopes			
Linear mean (Ml)	3.943	.071	55.774***
Linear variance (Dl)	2.501	.272	9.199***
Quadratic mean (Mq)	-.220	.013	-16.431***
Quadratic variance (Dq)	.066	.010	6.955***
Covariances			
Intercept with linear slope (Ril)	2.046	.298	6.871***
Intercept with quadratic slope (Riq)	-.376	.053	-7.146***
Linear with quadratic slope (Rlq)	-.382	.049	-7.831***
Residual variances			
Gr. 2 Spelling (E2)	1.550	.309	5.013***
Gr. 3 Spelling (E3)	3.903	0.234	16.680***
Gr. 4 Spelling (E4)	3.678	.248	14.834***
Gr. 5 Spelling (E5)	3.308	.248	13.336***
Gr. 6 Spelling (E6)	3.812	.274	13.900***
Gr. 7 Spelling (E7)	3.763	.503	7.475***

***p < . 001 Parameter estimate is significantly different from zero

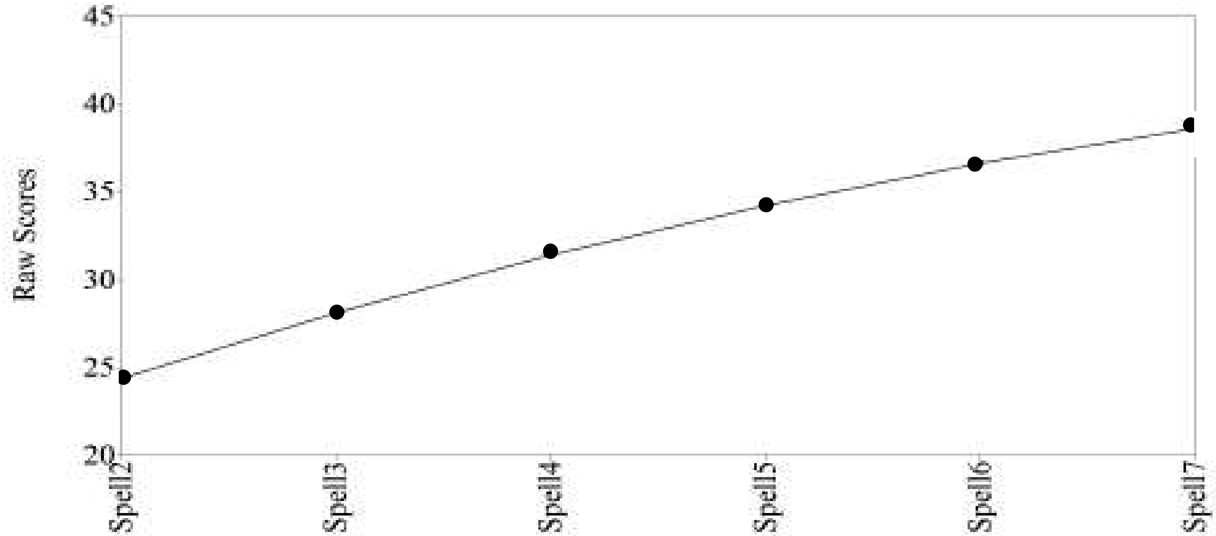

Figure 4.18. Estimated growth trajectory for spelling.

Spelling: Cognitive-Linguistic Predictor Model

The conditional growth model for spelling is the same as shown for word recognition in Figure 4.4. This model was fit simultaneously for L1 and EAL in a MG-LGM. The nested model testing is summarized in Table 4.23.

Table 4.23

Nested models for predictor MG-LGM of spelling

Model	RMSEA	CFI	Δ_{CFI}
Predictors (Covariates)			
4. Regression coefficients free	.035	.995	-----
5. Invariance of regression coefficients	.039	.993	-.002
6. Invariance of all parameters	.055	.981	-.012*

* non-invariant

Compared to the baseline Model 1 with regression coefficients freely estimated, Model 2 with the regression coefficients constrained to be equal across L1 and EAL groups did not significantly worsen model fit. However, the subsequent Model 3 specifying equality of all other parameters worsened model fit (change in CFI of -.012). Thus, Model 2 was retained as the final conditional MG-LGM for spelling: RMSEA = .039, RMSEA 90% CI = .025 - .052, CFI = .993, $\chi^2(51) = 87.884$, $p < .001$. There were no differences across L1 and EAL children in the predictive relations between the cognitive-linguistic covariates and the growth factors. The parameter estimates for the predictor model are shown in Table 4.24.

Table 4.24

Estimates for predictor MG-LGM of spelling

	Unstandardized Estimate	SE	z-value
Effect on intercept			
Verbal working memory	.067	.057	1.169
Syntactic awareness	.303	.053	5.729***
Phonological processing	.238	.015	15.677***
Effect on linear slope			
Verbal working memory	.092	.045	2.036*
Syntactic awareness	.127	.042	3.016**
Phonological processing	.070	.012	5.773***
Effect on quadratic slope			
Verbal working memory	-.015	.009	-1.699
Syntactic awareness	-.014	.008	-1.746
Phonological processing	-.014	.002	-5.977***

**p* < .05, ***p* < .01, ****p* < .001 Parameter estimate is significantly different from zero

Syntactic awareness and phonological processing were positive predictors of children's spelling performance at the initial level (intercept). However, verbal working memory was not a significant predictor at the initial level when the effects of syntactic awareness and phonological processing were accounted for. All three cognitive-linguistic skills were significant positive predictors of the linear slope. In contrast, only phonological processing was predictive of the deceleration term (quadratic slope), and the relationship was negative. For L1 children, the predictors accounted for 37.5% of the variance in spelling at the initial level, 14.7% of the variance in the linear trend, and 16.2% of the variance in the quadratic trend. For EAL children, the predictors accounted for 33.9% of the variance in spelling at the initial level, 16.6% of the variance in the linear trend, and 20% of the variance in the quadratic trend.

Development of Literacy Skills for Normally Achieving and Poor Readers

The third aim of this study was to examine whether there were differences in the growth trajectories for normally achieving (NA) and poor readers (PR). It should be reminded that 64 children with borderline reading skills were neither categorized into the NA nor PR group. These children were excluded from this set of analyses. There were 828 NA and 63 PR children in the total subsample. Given the small number of children falling in the PR group, attempts to fit a separate LGM for PR children did not converge. Thus, group differences for NA vs. PR could not analyzed via fitting simultaneous models for NA and PR. However, differences between NA and PR can still be captured to some extent by way of representing reader group differences using a time-invariant predictor coded as 0 for NA and 1 for PR. A MG-LGM for L1 and EAL was conducted with dummy coded predictor (hereafter referred to as "reader group") regressed on the intercept and slope growth factors for each model. This allows for examination of (a) whether there is a difference between children classified as NA vs. PR and (b) whether the difference between NA and PR children is invariant for L1 and EAL children. A significant regression coefficient for reader group indicates a reader group difference for that particular growth factor. However, since PR children had weaker skills than NA children in verbal working memory, phonological processing, and syntactic awareness (shown previously on Table 3.2), these pre-existing differences in skills were controlled for by entering them in the model as covariates.

Reader Group Differences across L1 and EAL Children

Models were simultaneously fit for L1 and EAL children in a MG-LGM. This helps to determine whether differences related to reader group are equal across L1 and EAL children. The second column in Table 4.25 shows the RMSEA fit index for the MG-LGM, and the fourth column shows the change in CFI for the nested model testing. The final three columns titled "effect" shows the regression coefficients for the reader group variable. The baseline model was one where the measurement parameters were held invariant across L1 and EAL children (to specify the same growth form) and the regression coefficients on growth factors were freely estimated (appears as "Estimated" in Table 4.25). Then the baseline model was compared to a model where the regression coefficients were held equal (i.e., "constrained) across language groups.

Table 4.25

Nested model testing for reader group status in MG-LGM

	RMSEA (90% CI)	CFI	Δ_{CFI}	Effect Intercept	Effect Slope	Effect Slope2/Quad
Word Recognition						
Estimated	.074 (.058-.090)	.975	-----			
Constrained	.070 (.056-.086)	.975	0	-9.555***	1.352***	-.159*
Word Fluency						
Estimated	.045 (.009-.075)	.995	-----			
Constrained	.033 (.000-.062)	.997	.002	-7.716***	.302	-.999
Decoding						
Estimated	.066 (.052-.081)	.980	-----			
Constrained	.064 (.050-.078)	.980	0	-24.992***	1.511***	-.183
Decoding Fluency						
Estimated	.056 (.037-.076)	.990	-----			
Constrained	.050 (.031-.069)	.991	.001	-17.024***	2.864***	1.464***
Reading Comp.						
Estimated	.079 (.066-.093)	.959	-----			
Constrained	.077 (.064-.090)	.959	0	-57.031***	4.218***	----
Spelling						
Estimated	.040 (.020-.058)	.995	-----			
Constrained	.046 (.029-.063)	.993	-.002	-4.717***	-1.610***	0.173**

*$p < .05$, **$p < .01$, ***$p < .001$ Significant differences

The resulting changes in CFI were all less than 0.01 suggesting that the reader group differences in initial status and rates of change are invariant for L1 and EAL children. That is, regardless of first language status, having a reading difficulty has the same pattern of detrimental effects on word recognition, word reading fluency, decoding, decoding fluency, reading comprehension, and spelling skills. Having established invariance of the model between L1 and EAL children, the interpretation can now be considered. Significant regression coefficients indicate significant reader group differences. The interpretation of the regression coefficients remain the same as for any other predictors: a one-point change in the predictor (reader group status going from NA=0 to PR=1) is associated with a change in the intercept or slopes by the given amount. Across all literacy models, significant regression coefficients indicate that NA and PR children differed in where they started (intercept) and how they grew over time (slopes).

In evaluating the normative scores for the children, poor readers as a whole (L1 and EAL combined) started off with a lower repertoire of literacy skills than normally achieving readers in grade 2. For word recognition PR children started with significantly lower achievement than NA children (NA mean percentile rank = 77.12, SD = 16.16; PR mean percentile rank = 18.00, SD = 9.06; $p < .001$, $d = 4.68$). They also read fewer words per minute than NA children (NA words per minute = 19.54, SD = 4.37; PR words per minute = 11.88, SD = 3.49; $p < .001$, $d = 1.95$). Compared to NA children, PR children were less accurate decoders (NA mean percentile rank = 77.89, SD = 18.31; PR mean percentile rank = 27.56, SD = 13.31; $p < .001$, $d = 3.18$) and less fluent decoders (NA pseudowords per minute = 25.61, SD = 8.07; PR pseudowords per minute = 8.52, SD = 5.35; $p < .001$, $d = 2.55$). PR children also started with lower reading comprehension levels than NA children (NA mean percentile rank = 56.16, SD = 21.62; PR mean percentile rank = 20.20, SD = 20.05; $p < .001$, $d = 1.73$). Finally, PR children had weaker spelling skills than NA children (NA mean percentile rank = 66.75, SD = 19.98; PR mean percentile rank = 28.07, SD = 18.70; $p < .001$, $d = 2.00$). Reader group differences for each literacy skill are explored further in the following sections.

Word Recognition: Normally Achieving vs. Poor Readers

As previously shown in Table 4.25, PR children scored 9.56 points lower than NA children in grade 2. Although PR children grew by 1.35 raw scores more than NA children in the linear part of development, they showed more negative deceleration. To illustrate the observed trajectory, the raw score means were plotted for NA and PR children in Figure 4.19. It appears that the observed trajectory for PR children is characterized by a persistent deficit over time rather than a developmental lag. That is, despite slightly greater growth in the early part, PR children do not ultimately catch up over time. However, the observed trajectories also do not suggest a Matthew effect for word recognition where the "the rich get richer, and the poor get poorer."

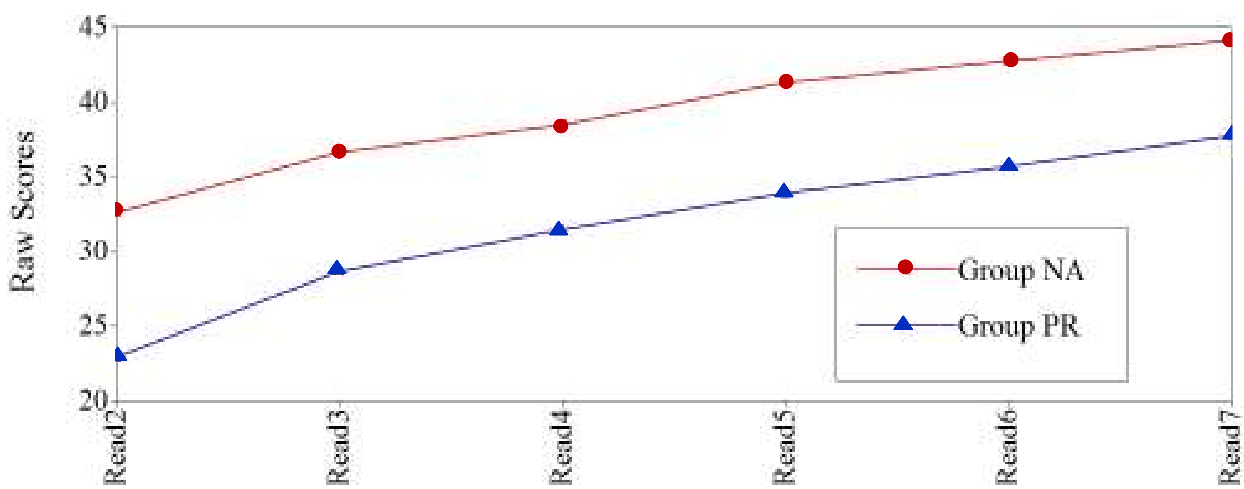

Figure 4.19. Plot of observed group means for NA and PR children in word recognition. Each reader group includes both L1 and EAL children.

The next MG-LGM analysis explored whether reader group differences persisted if the pre-existing differences in verbal working memory, syntactic awareness, and phonological processing were accounted for in the model (i.e., simultaneously entered as time invariant covariates). Reader group and the three cognitive-linguistic covariates were constrained to be equal across L1 and EAL children. The model resulted in the following fit indices: RMSEA = .054, RMSEA 90% CI = .042 - .066, CFI = .976, $\chi^2(60) = 137.983$, $p < .001$. There continued to be a reader group difference even after the cognitive-linguistic skills were accounted for (reader group on intercept = -6.282, $p < .001$; reader group on linear trend = 1.095, $p < .01$; reader group on quadratic trend = -.156, $p < .05$).

Word Reading Fluency: Normally Achieving vs. Poor Readers

Although PR children read 7.72 fewer words per minute than NA children in grade 3, both had the same rate of growth in word reading fluency from grades 3 to 6. The observed trajectory, as shown in Figure 4.20, is one with a persistent gap between NA and PR.

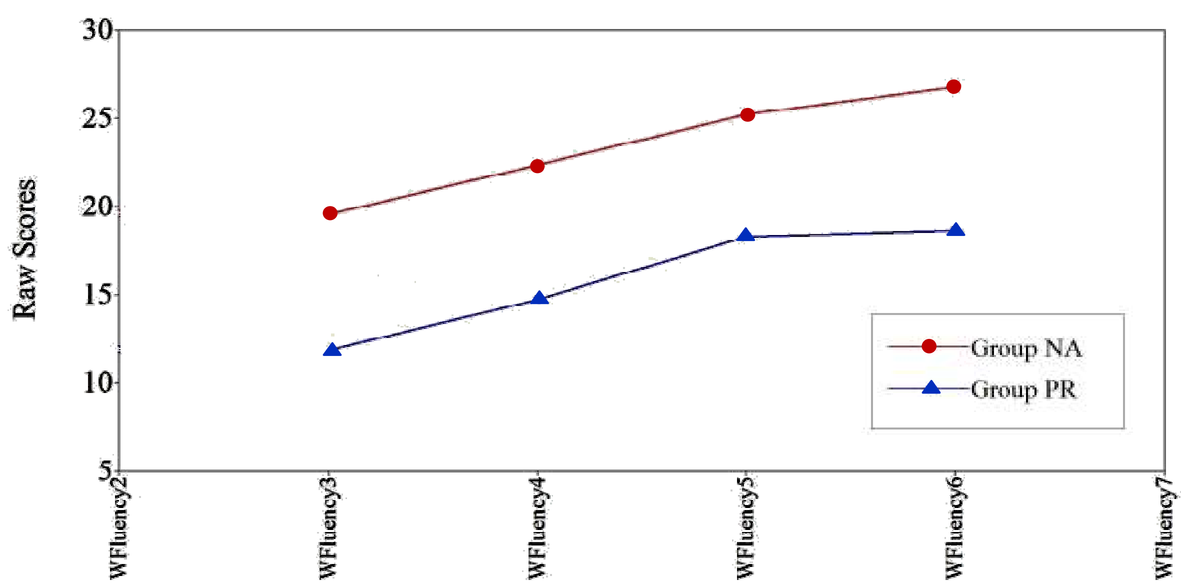

Figure 4.20. Plot of observed group means for NA and PR children in word reading fluency. Each reader group includes both L1 and EAL children.

Next, reader group and the three cognitive-linguistic covariates were constrained to be equal across L1 and EAL children. The model resulted in the following fit indices: RMSEA = .026, RMSEA 90% CI = .000 - .047, CFI = .996, $\chi^2(28) = 36.257$, $p < .001$. There continued to be a reader group difference even after the effects of the cognitive-linguistic skills were accounted for (reader group on intercept = -4.889, $p < .001$).

Decoding: Normally Achieving vs. Poor Readers

As previously shown in Table 4.25, PR children's decoding skill was 24.99 W score points lower than NA children at the start. PR children grew by 1.51 W score points more each year than NA children. However, there was no reader group difference in how NA and PR children plateaued after grade 6. Like word recognition, the plot of observed scores for PR children suggests a persistent deficit rather than a developmental lag (Figure 4.21).

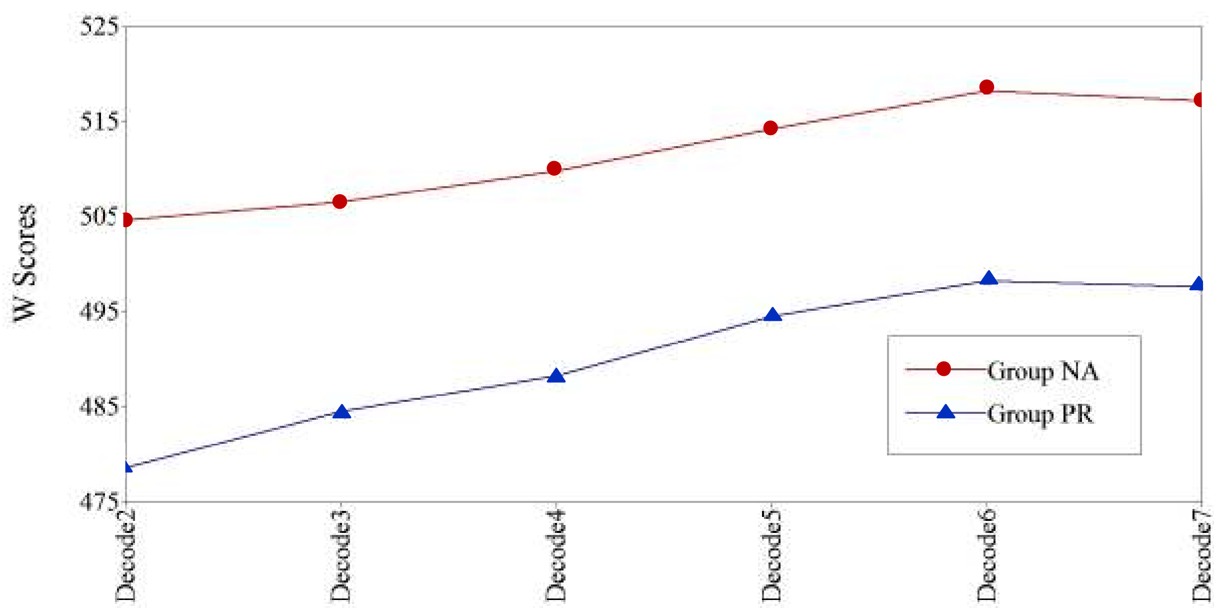

Figure 4.21. Plot of observed group means for NA and PR children in decoding. Each reader group includes both L1 and EAL children.

When verbal working memory, syntactic awareness, and phonological processing were entered into the model and thus accounted for, there continued to be a difference between NA and PR (reader group on intercept = -15.720, $p < .001$; reader group on slope 1 = .877, $p < .05$; reader group on slope 2 = -.812, p = ns). The decoding model resulted in the following fit indices: RMSEA = .050, RMSEA 90% CI = .038 - .061, CFI = .981, $\chi^2(66) = 139.098$, $p < .001$.

Decoding Fluency: Normally Achieving vs. Poor Readers

PR children read 17.02 fewer pseudowords per minute than NA children in grade 2. However, PR children also experience steeper rates of growth over time by 2.86 more pseudowords per minute from grades 2 to 3 and 1.46 more pseudowords per minute from grades 3 to 6. The plotted observed scores for NA and PR are shown in Figure 4.22. Although the PR children reduce the distance between themselves and the NA children over time, a gap still exists at least in grade 6.

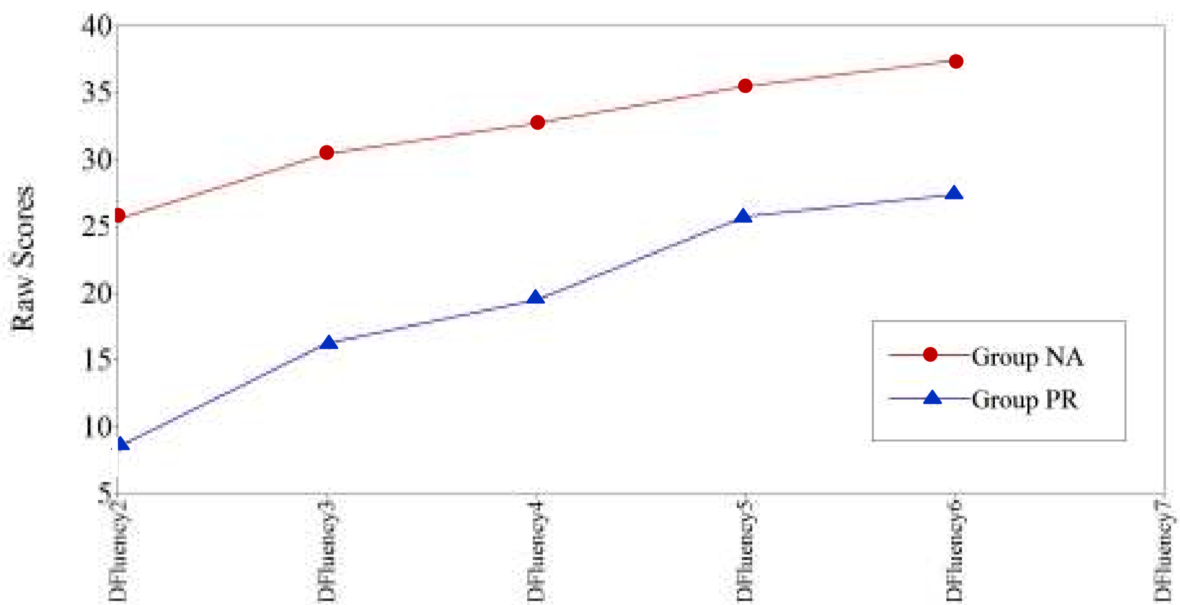

Figure 4.22. Plot of observed group means for NA and PR children in decoding fluency. Each reader group includes both L1 and EAL children.

When reader group and the cognitive-linguistic covariates were constrained to be equal across L1 and EAL children, the model resulted in the following fit indices: RMSEA = .040, RMSEA 90% CI = .025 - .055, CFI = .990, $\chi^2(46) = 79.307$, $p < .01$. After controlling for the effects of the cognitive-linguistic skills, reader group difference continued to be significant for the intercept (effect = -10.858, $p < .001$) and slope 2 (effect = .667, $p < .05$). However, there did not continue to be a group difference in slope 1(effect = 1.294, p = ns).

Reading Comprehension: Normally Achieving vs. Poor Readers

As seen in Table 4.25, PR children started at 57.03 standard points lower but grew faster than the NA children on reading comprehension by 4.22 standard points per year. Although there remains a persistent gap between PR and NA children from grades 2 through 7, PR children appear to reduce that gap over time. Figure 4.23 suggests that the development of reading comprehension skill proceeds more smoothly (less "up and down") for NA children than PR children. However, this is merely an observation and was not empirically investigated in this study due to issues of sample size.

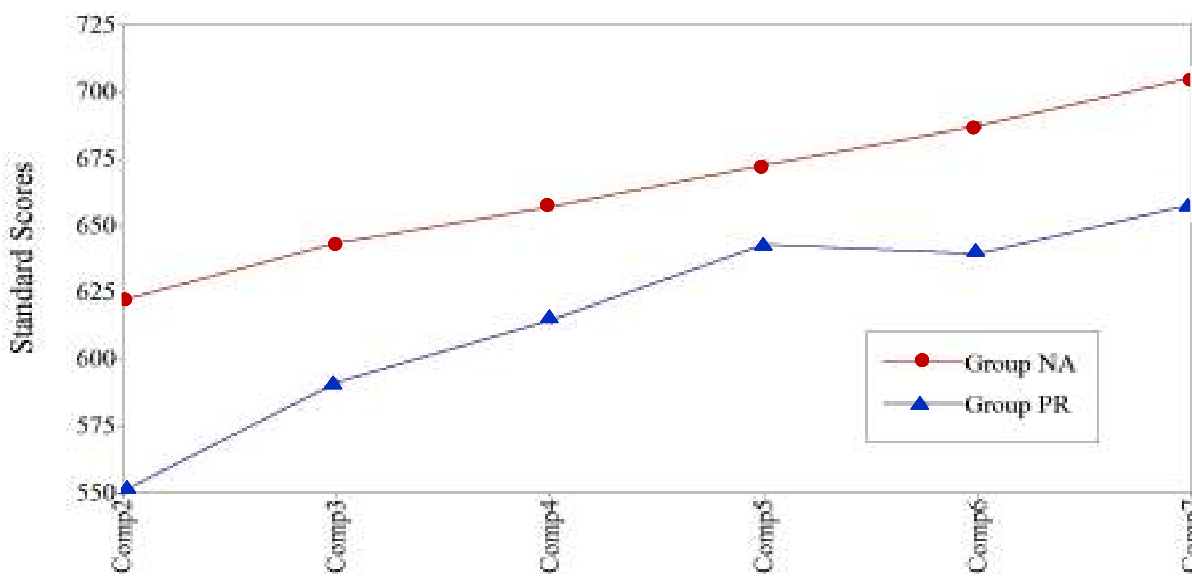

Figure 4.23. Plot of observed group means for NA and PR children in reading comprehension. Each reader group includes both L1 and EAL children.

Reader group differences persisted even after the effects of the cognitive-linguistic skills were accounted for (reader group on intercept = -39.067, $p < .001$; reader group on slope = 4.829, $p < .001$). The reading comprehension model resulted in the following fit indices: RMSEA = .067, RMSEA 90% CI = .057 - .078, CFI = .953, $\chi^2(72) = 217.344$, $p < .001$.

Spelling: Normally Achieving vs. Poor Readers

Figure 4.24 suggests that spelling development for PR children might be characterized by a persistent deficit that becomes greater over time (i.e., Matthew effect). PR children scored 4.72 points lower than NA children in grade 2, grew more slowly in the early part, and decelerated more slowly in the latter part. When the cognitive-linguistic skills were additionally entered into the model, the model resulted in the following fit indices: RMSEA = .047, RMSEA 90% CI = .034 - .059, CFI = .988, $\chi^2(60) = 117.931$, $p < .001$. After controlling for the effects of the cognitive-linguistic skills, reader group difference continued to be significant for the intercept (effect = -2.621, $p < .001$) and linear trend (effect = -.884, $p < .01$). However, there did not continue to be a group difference in the quadratic trend (effect = .028, p = ns).

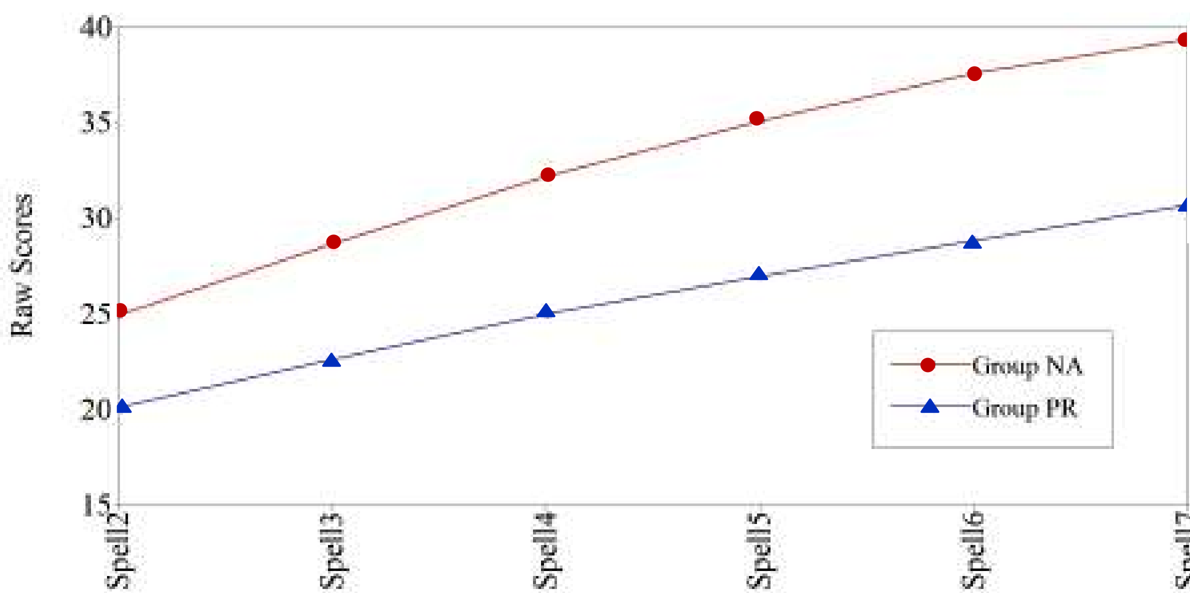

Figure 4.24. Plot of observed group means for NA and PR children in spelling. Each reader group includes both L1 and EAL children.

Parallel Process Model for Reading and Spelling

The fourth and final aim of this study was to explore the relationship between the development of word recognition and spelling skills. The parallel process latent growth model is shown in Figure 4.25.

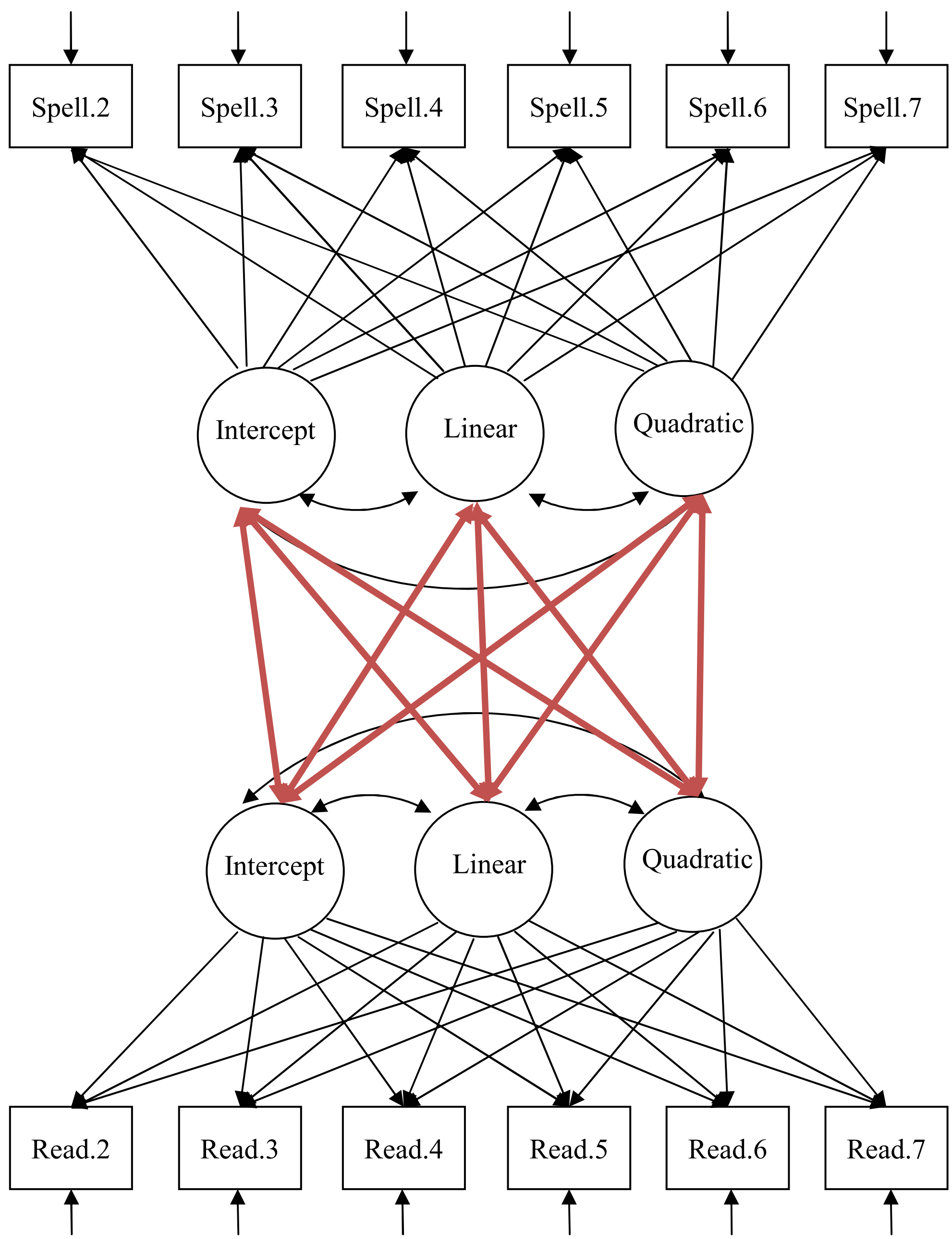

Figure 4.25. Parallel process growth model for word recognition and spelling. Parameter notations were excluded from the figure.

Given the invariance between L1 and EAL models for word recognition and spelling, the data for the L1 and EAL children were combined in a single parallel process model. As found in previous analyses, the development of word recognition and spelling both followed a quadratic form. The parallel model resulted in the following fit indices: RMSEA = .041, RMSEA 90% CI = .033 - .050, CFI = .991, $\chi^2(51) = 133.784$, $p < .001$. Of interest, however, were the covariance estimates between the word recognition growth factors and the spelling growth factors (appear as thick red arrows in Figure 4.25). The covariance estimates for the model are displayed in Table 4.26. The covariance between the intercepts is positive. This means that higher scores on word recognition are associated with higher scores on spelling and vice versa. The covariance between the linear trends is positive. This means that higher linear slopes in word recognition are associated with higher linear slopes in spelling and vice versa. A positive covariance between the quadratic trends indicates that more negative deceleration in growth in word recognition over time is also associated with more negative deceleration in spelling.

Table 4.26

Covariance estimates for parallel growth model

	Reading intercept	Reading linear	Reading quadratic
Spelling intercept	10.269***	-1.056***	.136
Spelling linear	3.648***	.547**	-.522*
Spelling quadratic	-.588***	-.064*	.472*

**p* < .05, ***p* < .01, ****p* < .001 Parameter estimate is significantly different from zero

CHAPTER 5: DISCUSSION

EAL speakers represent a culturally significant group in Canada and the impact of this sub-population is striking. An increasing number of children are entering the school system with little or no English language experience and are mainstreamed into English classrooms. This poses challenges for the school system as relatively little is known about the processes involved with EAL reading acquisition compared to the processes involved with English L1 reading acquisition. As a result, debates have arisen regarding the appropriateness of the use of L1 practices for EAL readers.

The present study is one of the first to comprehensively examine models of growth for word recognition, word reading fluency, decoding, decoding fluency, reading comprehension, and spelling in the same group of children over the middle childhood years. The present study involved the students in an entire school district from grades 2 through 7. The school district was one that was committed to the prevention and early identification of reading difficulties. The method of reading instruction was rooted in evidence-based strategies that were most effective for struggling readers. L1 and EAL children were taught in the same classrooms, and EAL children did not receive differential reading instruction because of their language status. The results of this study add weight to the argument for early identification and remediation of EAL reading difficulties regardless of oral language proficiency. The findings also speak to the universal benefit of an enriched literacy program that has far reaching benefits extending to at least the beginning of high school.

In this chapter, an integrative summary of the findings is organized under the relevant research questions. The strengths and limitations of the present study are then discussed. Finally, the chapter concludes with the implications for practice.

Integrative Summary of Findings

To review, this study was guided by the following four research questions:

(1) Are there common developmental models for L1 and EAL children?

Hypotheses: Growth for L1 and EAL children on all measures of literacy will be characterized by common developmental models. However, the shape of growth for each literacy skill may vary.

(2) How well do cognitive-linguistic skills at grade 2 predict initial levels and rates of change?

Hypothesis: Phonological processing, syntactic awareness, and verbal working memory will be significant predictors on initial skill level and in the rates of change for all literacy skills.

(3) Are there group differences related to reader status (Normally Achieving or Poor Readers) in the growth trajectories of literacy skills?

Hypotheses: There will be a significant reader group difference at initial status and in the rates of change. There will continue to be a difference even when cognitive-linguistic skills are accounted for.

(4) To what extent does the growth in spelling parallel the growth in word recognition?

Hypotheses: There will be a significant relationship between word recognition and spelling, specifically where children start and how they grow. Stronger word recognition skills will be associated with stronger spelling skills.

Research Question 1: Common Developmental Models

Invariant L1 and EAL Models. Lesaux et al. (2007) were the first to report that the growth model for word recognition skills were invariant for L1 and EAL children. The present study extends the work of Lesaux et al. to include a greater breadth of literacy skills beyond word recognition. The unconditional LGMs revealed common developmental models for L1 and EAL on all literacy skills examined: word recognition, word reading fluency, decoding,

decoding fluency, reading comprehension, and spelling. This indicates that the growth in reading and spelling unfolds in the same way regardless of EAL status. This is true for the shape of growth as well as the initial levels of achievement and rates of change over time. The fact that L1 and EAL children are highly similar in this population is not surprising given that the EAL children received the same instruction and attended the same classrooms as the L1 children. The findings of non-linear models for word recognition and decoding are consistent with the limited amount of existing literature comparing L1 and EAL through latent growth modeling (e.g., Kieffer, 2011; Kieffer & Vukovic, 2011; Lesaux et al.). Unfortunately, comparative L1/EAL studies using growth modeling for reading comprehension, word reading fluency, decoding fluency, and spelling are practically non-existent. Thus, there is little to compare the current findings to.

Different Growth Forms for Different Skills. There is not a uniform way that children develop across literacy skills. While there were no differences related to language group, the shape of growth for each literacy skill varied. For basic entry skills that focus on accuracy, such as word recognition, decoding, and spelling, the LGMs suggest there is some sort of ceiling to development. For word recognition and spelling, the shape is quadratic with growth slowing over time. For decoding, there is linear growth up until grade 6 after which it plateaus. Early readers and spellers learn to be literate by mastering the phonological coding process. That is, from a dual-route perspective there may be heavier reliance on the phonological route in the earlier stages of reading. Thus the phonological route can only get a child so far in reading. Advanced readers will use other skills to read. This can be exemplified by the fact that accuracy reaches a ceiling whereas fluency continues to grow. It is possible that as reading becomes more advanced there is greater involvement of the orthographic route such that lexical access becomes automatic, thus allowing the students to read more efficiently. Unfortunately, the growth models for word reading fluency and decoding fluency show only part of the trajectory (e.g. grades 3 through 6 for word reading fluency and grades 2 through 6 for decoding fluency). Without fluency data for grade 7, it is not known whether fluency will also slow down or plateau over time. One possibility is that fluency continues to grow even after accuracy has reached a maximum.

In contrast to basic level literacy skills, reading comprehension grows at a steady rate from grades 2 through 7. Whether reading comprehension continues to grow in a linear fashion through adolescent and adulthood remains to be seen. One surprising finding, however, was the lack of relationship between children's initial reading comprehension levels and their rates of change. Thus there was neither a disadvantage nor an advantage to being a low or high achiever at the initial onset. While surprising, the finding is not completely unexpected if one were to consider the Simple View of Reading. Either word recognition or oral language skills have the ability to mediate the development of reading comprehension over time. Even if word recognition reaches an apex, reading comprehension can continue to grow contingent on maturing language skills. Moreover, even if there are weak oral language skills, reading comprehension can continue to grow contingent on word recognition skills.

Research Question 2: Cognitive-Linguistic Predictors

Phonological processing and verbal working memory for EAL children strongly resembled those of L1 children. However, L1 children had stronger syntactic awareness than EAL children: L1 mean = 7.56, SD = 1.704; EAL mean = 6.57, SD = 2.09; $t(953) = 6.775$, $p < .001$. Similar results have been found in other studies (e.g., Chiappe & Siegel, 1999; Da Fontoura & Siegel, 1995). Since the oral cloze measure used in this study is similar to those used to assess oral language proficiency, this finding is consistent with the notion that EAL children are indeed behind L1 children in oral language proficiency, at least in grade 2. Yet, the results of this study show that this did not put EAL children at a disadvantage in the development literacy skills. When EAL and L1 children had equal access to instruction, they benefitted the same. This would add to the existing literature that EAL children become competent readers despite lower oral language proficiency at entry.

Significant Effects of Cognitive Linguistic Factors on Initial Achievement Status. In general, verbal working memory, syntactic awareness, and phonological processing were significant predictors of initial achievement levels. Children who were stronger in these cognitive-linguistic skills had better starts across word recognition, word reading fluency, decoding, decoding fluency, reading comprehension, and spelling than children who were weaker in cognitive-linguistic skills. The cognitive-linguistic predictors tended to have slightly higher predictive power for EAL than L1 initial reading status. For L1 children, the predictors accounted for 46.5% of the variance in word recognition, 33.2% of the variance in word reading fluency, 42.5% of the variance in decoding, 46% of the variance in decoding fluency, and 41.8% of the variance in reading comprehension. For EAL children, the predictors accounted for 51% of the variance in word recognition, 37.3% of the variance in word reading fluency, 46.2% of the variance in decoding, 49.7% of the variance in decoding fluency, and 48.9% of the variance in reading comprehension. The opposite pattern is true for spelling. The cognitive linguistic predictors tended to have slightly higher predictive power for L1 than EAL spelling development. For L1 children the predictors accounted for 37.5% of the variance in spelling while for EAL children the predictors accounted for 33.9% of the variance in spelling.

Significant Effects of Cognitive Linguistic Factors on Rates of Change. The cognitive-linguistic skills were not always good predictors of rates of change over time. Phonological processing emerged as the only predictor of rate of change in word recognition skills. Children who had weaker phonological processing skills had steeper growth in word recognition during the linear period. Although counterintuitive, it is possible that children who have yet to master phonological skills have more room to grow, and children who have mastered phonological skills have less room to grow. The deceleration in growth in word recognition was not associated with any of the cognitive-linguistic predictors. The cognitive-linguistic skills were also unrelated to the growth in word reading fluency over time. Syntactic awareness and phonological processing but not verbal working memory, explained some of the variability in upward growth in decoding and decoding fluency. In fact, children who grew the most were the ones with weaker syntactic awareness and phonological processing in grade 2. All three cognitive-linguistic skills were significant positive predictors of the linear slope in spelling. In contrast, only phonological processing was predictive of the deceleration term (quadratic slope), and the relationship was negative, meaning that weaker phonological processing was associated with more negative deceleration. For reading comprehension, none of the cognitive-linguistic skills emerged as significant predictors in the rate of change. Thus for reading comprehension, neither initial levels of reading comprehension nor any of the cognitive-linguistic skills examined in this study could explain how children grew in reading comprehension over time.

Verbal working memory, syntactic awareness, and phonological processing have been shown in the literature to be predictive of literacy skills. However, most of the evidence comes from longitudinal research using regression analyses of predictors on some later skill rather than examining the effect on the rates of change. The fact that, in this study, the three cognitive-linguistic skills were not always good predictors of rates of change hints at the possibility that (a) there are other cogent predictors not included in the model and/or (b) the effects the three predictors are time varying rather than time invariant as modeled. Time-invariant, indirect effects are via the cognitive-linguistic predictors' influence on the growth factors. Thus, the effects are modeled as uniform over time. In contrast, time-variant, direct effects are via the predictors influence on the outcome variables. As such, the effects can be modeled differently from one year to the next. Although there is no available literature from latent modeling studies to guide whether the effects of cognitive-linguistic predictors would be time variant or invariant, there is some evidence in the literature to suggest that cognitive-linguistic skills have different relationships with literacy skills over time.

According to Evans, Floyd, McGrew, and Leforgee (2001), phonemic awareness has a moderate relationship with basic reading skills and reading comprehension primarily through the early elementary school years (ages 6 to approximately 9) after which the relationship is reduced or becomes non-significant. Working memory has a consistent moderate relationship to basic reading skills from ages 5 through 20. The relationship between working memory and reading comprehension peaks at age 6 and remains moderate through to adolescence although there is a slightly downward trend. The authors suggest that working memory may decrease in importance during reading comprehension as the reading process becomes more automated and thus requires less of working memory. Another study suggesting time varying influences is that of Jongejan et al. (2007) who followed a group of L1 and EAL children from grades 1 through 4. The authors found that phonological processing, syntactic awareness, and verbal working memory were more strongly correlated with word recognition in the middle grades (grades 3 to 4) than in the lower grades (grades 1 to 2). Similarly, syntactic awareness and verbal working memory were more strongly related to spelling in the middle grades than lower grades. The only area of difference for L1 and EAL children was in the correlation between phonological processing and spelling. For L1 children, phonological processing showed a stronger correlation for middle grades than lower grades. The opposite was true for EAL children.

In summary, time varying effects could be the reason why phonological processing, verbal working memory, and syntactic awareness were not found to be good predictors of rates of change within a model specifying time invariant effects. However, it could also be true that the cogent predictors of rates of change have not been represented in this study. For instance, the conditional latent growth models of reading presented in this study were limited to linguistic predictors. From a dual-route perspective, only the phonological route was represented. Thus it is likely that a model which includes an orthographic predictor of reading, such as visual memory, will have greater explanatory power.

Research Question 3: Normally Achieving vs. Poor Readers

L1 poor readers and EAL poor readers shared the same pattern of growth in word recognition, word reading fluency, decoding, decoding fluency, reading comprehension, and spelling. This is evidenced by invariance testing of the reader group status on growth across the L1 and EAL models. As expected, PR children differed from NA children in their literacy skills. Although PR children grew slightly faster than NA children in parts of the trajectory for word recognition, decoding and decoding fluency, they were so behind that catching up was not possible by grade 7. This finding is consistent with Shaywitz et al.'s (1999) study with English L1 children and Swanson et al.'s (2006) study with Spanish children. This suggests a deficit model of poor reading rather than a developmental lag or a Matthew effect. When the pre-existing differences in cognitive-linguistic skills between NA and PR were taken into consideration through entering them as covariate predictors, the group differences related to reader status continued to exist. The development of spelling for PR children was even less promising. Spelling development for PR children was that of increasingly poorer performance compared to NA children. Moreover, the PR children grew slower than NA children by 1.6 raw score points per year, thus gradually losing ground and resulting in what may be a Matthew effect in spelling for poor readers.

For reading comprehension, the PR children grew faster than NA children each year yet there a gap remained at the end of grade 7. The question remains whether PR children will ever close this gap if development continues in the same fashion into adulthood. While a possibility, a variety of factors would need to be considered. For instance, PR children may be using greater cognitive resources than NA children to read a word, thus limiting the resources available for meaning making and other cognitive tasks required of reading comprehension. However, reading comprehension is such a complex skill that there are many influences to success beyond that of whether a child can read or decode a word. For instance, reading comprehension at later grades increasingly emphasizes other factors such as prior knowledge, context, vocabulary, and implicit meaning. Hence, fluent reading will only get one so far in reading comprehension.

Research Question 4: Parallel Processes for Reading and Spelling

The current finding is that good readers make for good spellers and vice versa. Steeper rates of growth in word recognition were associated with steeper rates of growth in spelling. Similarly, rates of deceleration in word recognition were associated with rates of deceleration in spelling. An interesting result from this study is that the relationship between where children started and how they grew was quite different for spelling than for word recognition. For word recognition, children with a lower start experienced a steeper rate of growth over time than children with a better start. Although counterintuitive, this has also been found in other research (e.g., Parrila et al., 2005). The opposite pattern was true for spelling. Children with a better start in spelling experienced a steeper rate of growth than children with a lower start. This suggests the possibility of a cumulative deficit in spelling for poor spellers, regardless of language status. This finding is consistent with what was found in the model of spelling development for PR children, especially considering that PR children were also poor spellers. Unfortunately, there is no comparative English study for this finding. The findings do diverge, however, from studies on spelling in shallow orthographies with highly predictable sound-letter mappings. In their study of Norwegian children attending the first three years of school, Lervag and Hulme (2010) found that spelling in Norwegian also followed a quadratic form. However, in contrast to the present findings, Lervag and Hulme found that spellers with a lower start showed the greatest growth over time. Aarnoutse, Leeuwe, Voeten, and Oud (2001) also found this in a longitudinal study with Dutch children in grades 1 through 6. As English is a relatively deep orthography compared to Norwegian and Dutch, it is unclear whether the regularity of the other languages contributed to their findings. If the orthographic depth of English is the only contributing factor to a cumulative deficit in spelling, then it follows that reading might be affected in the same way. However, this was not found in the present study. Although spelling and reading share a common set of underlying cognitive skills, the sequence of processes for output and degree of emphasis on each area of cognition may be different. The current finding can also be partly attributed to the experiences of the study sample. Perhaps, the fact that the children received a systematic program in reading, but not in spelling, might be one of the contributing factors to why a low initial start was associated with a slower growth rate in spelling but not in reading.

Strengths and Limitations

The present study contributes to the current literature in several ways. A longitudinal design allowed for the prospective examination of literacy skills over a period of time when learning to read and spell is central to children's educational outcomes. While the notion of a longitudinal design in educational research is not unique, most of the available literature on EAL literacy development focuses on mean differences and development across two time periods. With only two time periods, there is not much to be said about the course of development other than that there is change. As such, this does not allow for the examination of how academic skills grow over time, for whom, and to what degree. One would consider this to be essential knowledge for curriculum development and remedial instruction. By following children over a span of six years and using a latent growth modeling approach, this study provided important descriptions on how children grew in their skills, how they varied in their growth, and what predicted successful acquisition of literacy skills. Even rarer was the simultaneous comparison of L1 and EAL models presented in this study. To date there have only been a select few studies published on this, and this study has extended those by expanding the focus from word recognition and/or decoding to include fluency, spelling, and reading comprehension. A further contribution to the field of learning disability in EAL populations is the finding of comparable growth parameters for EAL and L1 poor readers. Thus, in this study a comprehensive and compelling picture of similarity between L1 and EAL development has been provided. Another important finding was that although EAL children were less proficient in oral language (as estimated by oral cloze) than L1 children, they were not at a disadvantage.

The study sample and instructional context also offered a unique opportunity to examine children who were taught using a universal design. The L1 and EAL children were in the same rich literacy environment receiving evidence-based instruction most indicated for children who struggle to learn to read, regardless of EAL status. The children were also monitored yearly, and those at risk received further intervention. The findings suggest that L1 and EAL similarly benefit from what is known to be best practices for L1 literacy instruction. However, being a poor reader has the same detrimental effects for all children, regardless of language status. This lends evidence to the need for early identification for EAL children with reading difficulties. Although a Matthew effect for reading was not found, a deficit model suggests that poor readers do not catch up despite having been immersed in this rich literacy environment and having received remedial instruction. This is an alarming finding because many school districts do not have universal screening or early intervention available to all children. Thus, one can only imagine what would happen to the progress of poor readers in school districts with limited access to resources.

There are some limitations to this current study. First of all, the EAL children received an evidence-based reading program and access to remediation as needed. This unique instructional context can affect the compensatory patterns in reading development. This could contribute to why no differences were found between L1 and EAL models. In absence of a comparison group, it is unknown whether the success of EAL children would be similar in another school district or another region with a different curriculum. In principle, a comparison group may have shown the same outcomes as the study group but this is not known. Second, the EAL group represented a diversity of languages (for instance alphabetic, non-alphabetic, orthographically deep, and orthographically shallow) and with varying degrees of bilingualism/multilingualism. What is known in the research is that some of these factors can facilitate or impede the learning process for EAL children. These factors might account for some of the variability seen in the initial levels and rates of change. Thus, further research may be necessary to determine whether results would be similar for a more language homogeneous EAL group and/or consider whether these differences can be modeled as latent classes of EAL learners. Particularly as the LGMs did not always provide an optimal fit, this suggests that the data may contain heterogeneity that cannot be captured by the conventional LGM with a single class grouping. Finally, this study examined grade 2 onwards, and thus there was not the ability to capture the acquisition of skills at the onset of instruction. Since literacy skills grow quickly in kindergarten and grade 1, the complete trajectory may not be represented. However, the same can be said for studies that only focus on the early years. Finally,

Implications for Practice

Considerable attention is being drawn towards the development of reading skills in children with diverse language backgrounds and evidence-based decision making in reading intervention. Not only should the remedial practices have proven effectiveness, but the practices should also be accessible and available to all children regardless of the etiology of the reading difficulty. The prevalence rate for poor reading in this study was 6.9% for L1 and 5.5% for EAL. This falls in the lower end of the range of prevalence estimates (Shaywitz & Shaywitz, 2003). From these figures, it would be difficult to argue that EAL reading difficulties are being overrepresented when English reading tests are used. The findings also suggest early instruction programs similar to the one offered in this study can have the potential for helping EAL children become as successful as their L1 peers. When EAL children have been provided with adequate opportunity to learn to read, they can do so successfully. Thus EAL status at school entry should not be used as a barrier to early identification when there is ample evidence to suggest a learning disability. Perhaps the ideal solution is one where all children receive intervention based on need rather than diagnoses. The debates around unduly labeling EAL children might then subside. If an assessment is required, the diagnosis of a reading disability might be considered in the same way given the highly similar nature of L1 and EAL literacy development. Since the word recognition process can be dissociated from oral language proficiency (i.e., linguistic comprehension), then it follows that word recognition can be a useful indicator for reading difficulty in EAL children. Ideally, measures in the EAL child's native language would also be desirable.

The growth models provided in this study further echo what is already known in the literature about the critical periods of growth and intervention. For instance, the growth in word recognition and spelling slows over time. Thus the critical periods for intervention would be at the early stages. Since decoding development ceilings by grade 6, a reading curriculum would not necessarily want to emphasize phonics instruction past this period. Reading comprehension shows steady linear growth and as such, reading strategies should be taught from school entry up until at least adolescence. For children identified as poor readers in grade 2, the prognosis is that they would continue to struggle. When the curriculum shifts from "learning to read" to "reading to learn," these children might find themselves much more unable to catch up. Thus poor readers need be identified earlier than grade 2. A final suggestion for practice is in relation to a systematic spelling curriculum. Although good reading drives good spelling, poor readers and poor spellers are still at a disadvantage. In order to prevent cumulative deficits, educators will want to consider how to help children reduce this over time with integrated reading and spelling curriculums.

Conclusion

A great deal of research has been dedicated to exploring the literacy skills of normally achieving EAL children and how specific linguistic factors influence their growth on reading and spelling. Although some researchers have found a positive transfer from the first to the additional language, other researchers have found a negative direction of influence (Jarvis, 2000). However, growing evidence suggest that bilingualism has a positive effect on learning and that normally achieving EAL children catch up to L1 peers much earlier than previously believed. This suggests that with adequate instruction, EAL children are not a disadvantage when it comes to acquiring literacy skills. What was highlighted in the preceding chapters is the similarity between how L1 and EAL children grow to be competent readers and spellers. Furthermore, for L1 and EAL children, having a reading problem is not just a problem of reading. Poor readers continue to be behind their peers in word recognition, word reading fluency, decoding, decoding fluency, reading comprehension, and spelling.

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APPENDICES

Appendix A. Working Memory for Words

Instructions: I am going to say some sentences and the last word in each sentence will be missing. I want you to tell me what you think the last word should be. Let's try one. "*For breakfast the little girl had orange* _________." Now I am going to read two sentences. After each sentence, I want you to tell me the word that should go at the end of the sentence. When I finish the two sentences, I want you to tell me the two words that you said for the end of each sentence. Please tell me the words in the order you said them. Let's try it. "When *we go swimming, we wear a bathing* __________." "*Cars have to stop at a red* __________."

Discontinue when the child has failed an entire level (all three items – A, B, C) of a level.

Note: Announce each new level. Record the words in the order the child has said them.

Items

2A (1) In a baseball game, the pitcher throws the ________________.

(2) On my two hands, I have ten ___________________________.

Child's responses: ____________________________________

2B (1) In the fall, we need to rake ______________________________.

(2) When we are sick, we often go to the ____________________.

Child's responses: ____________________________________

2C (1) An elephant is big, a mouse is __________________________.

(2) A saw is used to cut __________________________________.

Child's responses: ____________________________________

3A (1) Running is fast, walking is ______________________________.

(2) At the library, people read ______________________________.

(3) An apple is red, a banana is ___________________________.

Child's responses: ____________________________________

3B (1) The sun shines during the day, the moon at _______________.

(2) In the spring, the farmer plows the _______________________.

(3) The young child had black hair and brown _________________.

Child's responses: ___________________________________

3C (1) In the summer it is very _______________________________.

(2) People go to see monkeys in a _________________________.

(3) With dinner, we sometimes eat bread and ________________.

Child's responses: ___________________________________

4A (1) Please pass the salt and ______________________________.

(2) When our hands are cold we wear ______________________.

(3) On my way to school I mailed a _________________________.

(4) After swimming, I was soaking _________________________.

Child's responses: ___________________________________

4B (1) Snow is white, coal is _______________________________.

(2) After school, the children walked ________________________.

(3) A bird flies, a fish ____________________________________.

(4) In the barn, the farmer milked the _______________________.

Child's responses: ___________________________________

4C (1) In the autumn, the leaves fall off the _____________________.

(2) We eat soup with a __________________________________.

(3) On hot days, I go to the pool to _________________________.

(4) We brush and comb our _______________________________.

Child's responses: ___________________________________

5A (1) For the party, the girl wore a pretty pink __________________.

(2) Cotton is soft and rocks are ___________________________.

(3) Once a week, mother washes the kitchen _________________.

(4) In the winter, we have to shovel ________________________.

(5) I throw the ball up and then it comes ____________________.

Child's responses: __________________________________

5B (1) The snail is slow, the rabbit is _________________________.

(2) At a birthday party, we usually eat ice cream and __________.

(3) Sand paper is rough but glass is _______________________.

(4) In a garden, the workers pick ears of ____________________.

(5) Over the field, the girl rode the galloping _________________.

Child's responses: ___________________________________

5C (1) To cut meat we use a sharp ___________________________.

(2) In the daytime it is light, and at night it is ________________.

(3) Dogs have four _____________________________________.

(4) At the grocery store we buy ___________________________.

(5) A man is big, a baby is ______________________________.

Child's responses: ___________________________________

TOTAL /12

Appendix B. Oral Cloze

Instructions: This time I will read something to you and there will be a word missing. Where the word is missing, I will say "beep". For example, I might say "The moon shines bright in the "beep." (pause and repeat) and I want you to say "sky." O.K. Let's try another one. I'll say "The children "beep" with the toys." (pause and repeat). What's the missing word? (If the child fails to respond, say "How about play? Then it would be "The children play with the toys." Let's try another one. "The little puppy wags its "beep." (pause and repeat). Good!

1. We have done the work already. We __________ it yesterday.
2. John is a good player. Bill is a better player than John. But Tom is the ________ player of them all.
3. Jane ______________her sister ran up the hill.
4. The brown dog is small; the gray dog is smaller; but the white one is the _____________.
5. Betty ___________ a hole with her shovel.
6. Yesterday, Tina and Marie _________ walking down the street.
7. The girl ___________ is tall plays basketball well.
8. The hungry dogs have ___________ all the food.
9. Jeffrey wanted to go _________the roller coaster.
10. Dad ___________ Bobby a letter several weeks ago.
11. Yesterday, Joe __________ the ball.

TOTAL /11