A LATENT GROWTH MODELING STUDY OF THE DEVELOPMENT OF READING COMPREHENSION IN ESL LEARNERS

by

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ABSTRACT

An important question in the field of reading development is whether models of reading, which apply largely to monolingual English (L1) learners, also apply to English as a Second Language (ESL) learners. The pursuit of such an inquiry is critical to the development of empirically valid models of reading in ESL populations. This study investigated the nature and determinants of the developmental pathways of reading comprehension in ESL (N=153) and L1 learners (N=593) from the fourth to the seventh grade. Two research questions guided the research: (1) How similar are ESL learners to L1 learners in their reading comprehension growth trajectories? (2) How similar are ESL learners to L1 learners in the determinants of their reading comprehension growth trajectories? The following basic processes of reading comprehension were examined: phonological awareness, pseudoword decoding, word identification, reading fluency, and syntactic awareness. Using latent growth modeling, the study found that ESL learners were identical to L1 learners in the functional form (both showed linear growth), slope or rate of growth, intra-individual variability, and linguistic determinants, of their reading comprehension growth trajectories. However, they were weaker than L1 learners in their reading comprehension skill levels. These results provide compelling support for the applicability of L1 models of reading comprehension for ESL learners, and help shape an emergent conceptualization of reading comprehension development for ESL learners.

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CO-AUTHORSHIP STATEMENT

Co-authors for this study are Dr. Linda Siegel and Dr. Bruno Zumbo. The main author was primarily responsible for the conceptualization, design, and data analyses of the study, as well as the preparation of the manuscript. Secondary data was used in this study, drawn from the longitudinal study of Dr. Linda Siegel.

CHAPTER 1. OVERVIEW OF THE RESEARCH

The research presented in this thesis focused on the development of reading comprehension in English as a Second Language (ESL) learners, examining whether existing models of reading comprehension development, which apply largely to native English speakers, also apply to children learning English as a second language. Individual growth trajectories of reading comprehension, and the linguistic determinants of these growth trajectories, in ESL and L1 learners, formed the bases of study. Specifically, we sought to determine whether the growth trajectories of reading comprehension, and the linguistic predictors of these trajectories, were identical for ESL and L1 learners. The study addresses the question of whether L1 models of reading comprehension apply to ESL learners, and shapes an emergent conceptualization of the development of reading comprehension in ESL learners.

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CHAPTER 2. A LATENT GROWTH MODELING STUDY OF THE DEVELOPMENT OF READING COMPREHENSION IN ESL LEARNERS[1]

The population of students learning English as an additional language has been growing in major English speaking countries throughout the world. In Canada, the population of elementary-aged students speaking a mother tongue other than English or French grew by 12.4% between 2001 and 2006, to reach 14.3% of the student population in 2006 (Statistics Canada, 2008). In the United States, the population of Limited English Proficiency (LEP) learners grew by 57% between 1996 ad 2006, far exceeding the corresponding 4% growth in the overall student population over the same period (National Clearinghouse for English Language Acquisition and Language Instruction Educational Programs, 2007). Considering the rapid pace of globalization, and its consequent impact on the rates of immigration, one can only expect such escalating growth trends in the number of students whose first languages are not English, to continue.

A key skill that English as a Second Language (ESL) learners need to acquire in order to be successful in school is reading. The ability to read in English is crucial to

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success within North American societies (August & Hakuta, 1997). The importance of reading toward life outcomes is well documented in the literature. An inability to read increases one's risk for a multitude of negative life outcomes, including low self-esteem, violence, depression and possibly suicide (Barwick & Siegel, 1996; McBride & Siegel, 1997). Ultimately, the goal of reading is to comprehend what one reads. Reading comprehension is critical to teaching and learning; without this critical skill, one's ability to access knowledge from printed material is heavily compromised.

Although a considerable amount of knowledge exists on the development of reading in children, this knowledge applies largely to native English speakers, the population upon which most of the research has been based. Whether this knowledge base is generalizable to ESL learners is a critical question that has yet to be conclusively addressed. ESL learners bring unique profiles of linguistic skills to the task of learning to read that may set their reading pathways apart from native English speakers. For example, at the point where native English speakers learn to read, they already possess an extensive store of receptive and expressive vocabulary in English. They are familiar with the grammar and syntax of the English language. By contrast, ESL learners typically do not bring such oral language competencies in the English language to their experiences of learning to read, a deficiency that, given the importance of oral language proficiency to reading acquisition, may potentially impede their progress in acquiring the skills of reading.

On the other hand, ESL learners bring unique linguistic skills from their native language(s) to the task of learning to read. According to Cummins' (1979) linguistic interdependence hypothesis, linguistic and/or academic skills acquired in the first

language transfer to the learning of a second language, and enhance, rather than hinder, its development. The term "common underlying proficiency" (Cummins, 1980) has been evoked to explain this process – CUP captures the notion of a central language processing system that supports both first and second language learning, and that facilitates such a transfer of skills and concepts from the first to the second language. Empirical findings support this conceptualization. Studies of diverse language groups, including languages whose orthographies are not based on the alphabetic code, show that linguistic competencies in the native languages do mediate positively in ESL learners' experiences of learning to read in a second language (Abu-Rabia & Siegel, 2002; Da Fontoura & Siegel, 1995; D'Anguilli, Siegel, & Serra, 2001; Durgunoglu, Nagy, & Hancin-Bhatt, 1993; Lindsey, Manis, & Bailey, 2003, Nagy, Garcia, Durgunoglu, & Hancin-Bhatt, 1993; Royer & Carlo, 1991).

Given their unique linguistic entry profiles, it is important that research efforts focus on investigating and defining the developmental pathways of reading in ESL learners. A relevant question to investigate is the extent to which these developmental pathways, or trajectories, are similar to L1 learners. In other words, do the reading skills of ESL learners develop in the same manner as L1 learners? In addition, do the variables that affect the development of reading in L1 learners affect the development of reading in ESL learners similarly? Such comparative knowledge is needed in informing the question of whether L1 reading models can be generalized to the ESL subpopulation. Ultimately, they are critical for developing more empirically valid explanatory models of reading for ESL learners.

Development of Reading Skills in ESL Learners

At least at the level of word reading, a growing body of empirical evidence indicates that ESL learners show very similar patterns of reading development to L1 learners (e.g., Lesaux, Koda, Siegel & Shanahan, 2006). The results from a number of international studies show consistently that ESL learners do as well as L1 learners on measures of phonological skills and word identification across grade levels after just one or two years of schooling, even though their oral language proficiency levels may be lower (Arab-Moghaddam & Sénéchal, 2001; Chiappe & Siegel, 1999; Chiappe, Siegel, & Gottardo, 2002; Chiappe, Siegel, & Wade-Woolley, 2002; da Fontoura & Siegel, 1995; Geva & Verhoeven, 2000; Geva, Yaghoub-Zadeh, & Schuster, 2000; Geva & Wang, 2001; Gottardo, Yan, Siegel, & Wade-Woolley, 2001; Lesaux & Siegel, 2003; Verhoeven, 2000). These findings cross diverse language groups in different countries, including Hebrew speaking, Chinese speaking, Punjabi speaking, French speaking, Persian speaking, and Arabic speaking children in Canada (Chiappe & Siegel, 1999; Chiappe, Siegel, & Gottardo, 2002; Comeau et al., 1999; da Fontoura & Siegel, 1995; Geva et al., 2000; Gottardo et al., 2001; Lesaux & Siegel, 2003), Turkish speaking children in the Netherlands (Verhoeven, 2000), and Spanish speaking children in the U.S. (Cisero & Royer, 1995; Lindsey et al., 2003).

In addition, many of these studies found that although oral reading proficiency correlates positively with word reading in ESL learners, it is not a strong predictor of word reading for them. Rather, phonological skills, a key predictor of reading in L1 learners, is equally a stronger predictor of word identification in ESL learners, accounting for the greatest amount of variance in word identification in ESL learners (Catts, Hogan,

& Fey, 2003; Chiappe, Siegel, & Gottardo, 2002; Comeau, Cormier, Grandmaison, & Lacroix, 1999; Durgunoglu, Nagy, & Hancin-Bhatt, 1993; Gottardo et al., 2001; Lesaux & Siegel, 2003; Lindsey, Manis, & Bailey, 2003).

These findings are substantial and form an adequate empirical base from which to hypothesize that existing models of word reading may be applicable to ESL learners. In other words, there is sufficient basis to expect ESL learners to show similar developmental pathways in their word reading skills to native English speakers; and to expect that as for L1 learners, boosting their phonological processing skills can have a direct and positive impact on their word reading skills. This constitutes important progress in the development of empirically valid theories of ESL reading development.

What this research seeks to determine is whether the conclusions about ESL learners' development of word reading skills extend to a more complex and multi-faceted set of reading skills, reading comprehension. For most L1 students, the ability to derive meaning from print develops as a natural progression from successful word reading development. The presumption is that by the third or fourth grade, children have "learned how to read and are now reading to learn" (Campbell, Kelly, Mullis, Martin, & Sainsbury, 2001, p.6). Reading comprehension has been described as the ultimate goal of reading. In school, achieving this transition in a timely manner is key to accessing learning from a curriculum that becomes increasingly content focused as children progress through their elementary grades. It is vital therefore that ESL learners, too, are successfully mediating this transition, and maintaining similar levels of growth as their L1 counterparts in this critical skill.

Unfortunately, research on the development of reading comprehension in ESL learners is much less common in comparison with research on their word level skills (Lesaux, Koda, Siegel and Shanahan, 2006). Garcia (1991) found that fifth and sixth grade Spanish speaking students learning English performed significantly more poorly than English monolingual students on a measure of reading comprehension. In his work in Dutch-speaking Netherlands, Verhoeven (Verhoeven, 1990; 2000) found consistent reading comprehension deficits in first and second grade minority Turkish-speaking students learning Dutch, even when their word reading skills were commensurate with the Dutch learners. These deficits persisted to upper grade levels. In their study, Aarts & Verhoeven (1999) showed that after eight years of schooling, Turkish-speaking minority children were significantly more poor than native Dutch speakers in their functional literacy (deriving meaning from print) skills. Together, these studies suggest that ESL learners may have deficits in their reading comprehension skills compared with L1 learners. Significant as such comparative studies in reading comprehension are, they are at the present time too rare and isolated. Until more comparative studies are conducted with different language groups under different educational contexts, broad generalizations about the comparability of reading comprehension skills in ESL learners to L1 learners, are not warranted at this time.

The idea that ESL learners may experience greater difficulties in attaining proficiency in reading comprehension compared with lower order word recognition skills, is conceivable, given its more complex and multi-faceted nature. Research with native English speakers has shown that a multitude of basic processes at the word, sentence, and text levels, are implicated in the development of reading comprehension

(e.g. Seigneuric & Ehrlich, 2005). In order to determine if L1 models of reading comprehension are applicable to ESL learners, it is also important to determine whether the key variables that influence reading comprehension in L1 learners, also influence reading comprehension in ESL learners.

Research with native English speakers shows that reading comprehension draws on an extensive number of linguistic and reading skills which include bottom-up, word recognition processes, and top-down, comprehension-related processes. The former encompass phonological awareness and word reading skills, including word decoding skills; the latter, oral language proficiency (vocabulary, grammatical and syntactical skills, listening comprehension), sentence and text inferential skills, and comprehension monitoring skills.

The roles that bottom-up word processes play in the development of reading comprehension is captured through staged models of reading (Adams, 1990; Chall, 1996; Ehri, 1992; Frith, 1985). These theories share an underlying principle that reading develops through a series of distinct stages or phases, each of which is contingent upon the successful development of a previous stage. According to Chall (1996), the process begins with the earliest phase, "pre-reading", characterized by the acquisition of grapheme-phoneme, or letter-sound, correspondences. During this period of learning, there is a high reliance on contextualized print and environmental cues. Children gradually understand that units of letters correspond to sounds. When this happens, they possess the foundational skills to move into the next stage, "initial reading and decoding". During this second stage, they master the alphabetic principles of the English language, and ultimately, begin word reading.

Having understood the English alphabetic code, young readers consolidate their newly acquired word decoding skills, and gain increasing fluency and automaticity in their reading. This stage, called "confirmation", is deemed critical for reading comprehension. Chall describes a process of "ungluing from print" (Chall, 1996, p.18) which occurs during this stage whereby children's attentional resources are freed up to allow them to focus on the meaning of words. According to Chall, such a level of comfort with print is necessary for children to move into the ultimate phase of reading comprehension, "reading for learning new information".

The conviction in the field is that it is the automatization of word reading, and subsequently, the attainment of fluency in reading, and not just reading accuracy alone, that is essential for successful reading comprehension to occur (Perfetti, 1992). Information processing models of reading, such as LaBerge and Samuels' (LaBerge & Samuels, 1974) automaticity model, and Perfetti's (Perfetti, 1985, 1988) verbal efficiency model, best explain the dynamics of this crucial relationship. According to these theories, automaticity or efficiency at the word level frees up limited attentional and working memory resources, which are reallocated away from lower order word processing (such as word decoding) to higher order, more resource demanding reading processes, namely text interpretation and comprehension. Empirically, researchers have found positive and high correlations between reading fluency and reading comprehension, whether the former is measured through word identification tasks (McCormick & Samuels, 1979; Perfetti & Hogaboam, 1975), or text reading tasks (Deno, Mirkin, & Chiang, 1982; Fuchs, Fuchs, & Maxwell, 1988; Fuchs, Fuchs, Hosp, & Jenkins, 2001).

The simple view of reading (Hoover and Gough, 1990) integrates both bottom-up and top-down processes by defining reading comprehension as the product of word decoding and linguistic comprehension, the latter measured typically through a vocabulary and/or listening comprehension measure. In other words, both word decoding skills and oral language proficiency are necessary for reading comprehension to occur successfully. Indeed, L1 studies have demonstrated strong associations between vocabulary and reading comprehension (Bast & Reitsma, 1998; Carroll, 1993; Muter, Hulme, Snowling, & Stevenson, 2004; de Jong & van de Leij, 2002; Torgeson, Wagner, Rashotte, Burgrss, & Hecht, 1997; Verhoeven, 2000); and listening comprehension and reading comprehension (Sears & Keogh, 1993).

Muter and colleagues (Muter, Hulme, Snowling, & Stevenson, 2004) showed that reading comprehension at second grade was predicted by earlier word identification skills, grammatical abilities and vocabulary. Oakhill and colleagues (Oakhill, Cain & Bryant, 2003) showed that vocabulary, inference skills, monitoring skills, and verbal IQ were significant predictors of reading comprehension at grades 3, 4 and 6. More recently, Siegel (2008) found that morphological awareness skills made significant contributions toward reading comprehension at 6th grade, over and above the effects of phonological awareness. Finally, de Jong and van der Leij (2002) showed that first and third grade word decoding, vocabulary and listening comprehension skills predicted fifth grade reading comprehension.

ESL predictor studies in reading comprehension are far fewer in comparison to L1 studies. A number of cross sectional studies demonstrate the importance of word level skills and oral language proficiency in the English language, to reading comprehension

for ESL learners from different language backgrounds. Reese and colleagues (Reese, Garnier, Gallimore, & Goldenberg, 2000) showed that early literacy skills of letter knowledge and decoding predicted later reading comprehension in Spanish speaking children learning English. Dufva and Voeten (1999) reported a strong correlation between oral vocabulary and reading comprehension in third grade Finnish students learning English. Peregoy and colleagues (Peregoy, 1989; Peregoy & Boyle, 1991) found that ESL learners in the middle grades with higher reading comprehension scores also had higher oral proficiency scores on tests of grammatical skills and listening comprehension. Royer and Carlo (1991) showed that at grades 5 and 6, listening comprehension was the best predictor of reading comprehension. Finally, Verhoeven (1990; 2000) demonstrated the importance of word reading efficiency and oral proficiency (vocabulary and syntax) to the reading comprehension skills of first and second grade Turkish speaking students learning Dutch.

Unfortunately, many of the ESL predictor studies had small sample sizes, biased samples, or did not include L1 reference samples, limiting generalizability of findings. Nevertheless, the available studies show fairly consistent links between word reading skills and oral language proficiency (vocabulary, grammar and listening comprehension), and reading comprehension development in ESL learners (e.g., Lesaux et al., 2006; Geva, 2006).

Developmental Pathways of Reading Comprehension in ESL Learners

Most studies investigating children's development of reading comprehension have not used a longitudinal design (Verhoeven & van Leeuwe, 2008). In so far as studies have compared reading comprehension performances of L1 and ESL learners, or

investigated the effects of predictors of reading comprehension development in either group, the data have mostly been cross-sectional. It is important to investigate the continuous developmental pathways, or trajectories, of ESL learners, and the determinants of these growth trajectories, over time. In addition, in order to draw meaningful conclusions about reading comprehension growth and development in ESL learners, it is vital that longitudinal designs incorporate L1 samples for reference and comparison.

The knowledge gained from the comparative study of the reading trajectories of ESL and L1 learners will have critical implications for the education of ESL learners. Two types of decision errors typically occur when educators evaluate the needs of ESL learners – one, ESL students with true reading disabilities are not identified for support because teachers give too much wait time for their skills to catch up (Type I decision error); and two, ESL students with no reading disabilities are erroneously identified as having special needs when teachers take action too hastily, not giving them sufficient time for their skills to naturally catch up (Type II decision error). Such decision errors with ESL learners can be greatly reduced with the knowledge of how their reading skills grow and change over time, in comparison to their L1 counterparts. Essentially, what educators need to know is if ESL learners can be expected to eventually catch up to their L1 counterparts, how long this typically takes, and how they can expediently close the gaps for ESL learners.

Regardless of whether their reading trajectories may be similar or not, the determinants of these trajectories may not be identical for ESL and L1 learners. Knowledge of the predictors of reading growth is critical in informing instruction and

support for ESL learners. Teachers can better plan or adapt instruction for their ESL learners when they know the pre-requisite and correlate skills that make the most impact on reading comprehension development for them at the different developmental stages.

Conventional approaches to studying growth and change in skills have often employed the difference score, comparing longitudinal data over two time-points, and looking for a significant change (increase or decrease) in scores. The use of difference scores to measure incremental change over two time points is in fact not ideal for studying development and growth, because it does not allow researchers to study the patterns of development (Rogosa & Willett, 1985; Rogosa, Brandt, & Zimowski, 1982). A more ideal methodology for studying growth, used in this study, is latent growth modeling (LGM). A special class of structural equation modeling, LGM allows researchers to model growth over multiple time-points, while capturing variance at both the intra- and inter-individual levels. LGM allows researchers to investigate multiple aspects of growth curves across multiple groups, for example, growth function, growth rates, and correlates of growth.

Longitudinal studies employing LGM methodology have been relatively scant in the reading field, and practically non-existent in ESL research. In addition, studies that have used growth modeling methods in investigating reading trajectories have mostly focused on reading at the word level, rather than reading comprehension. This has largely to do with the stringent requirements of growth modeling methodology. One requirement is the conceptual criterion of measurement invariance, or the requirement that the same construct or trait be measured or assessed over time. This is best achieved when the same measurement tool is used over all repeated measures. Understandably,

this criterion is more easily met with word reading than reading comprehension measures. The former tend to deploy the same word list(s) over wide age ranges. On the other hand, reading comprehension measures tend to cover more narrow age ranges, and to use qualitatively different passages and questions for different age bands.

Yet a more challenging requirement of LGM is that of the suitability of the instrument in allowing for interval scaling of individuals on the construct of measure. This is a potential hurdle for researchers as most cognitive and academic assessment measures use scoring metrics that do not allow for scores to be translated to an interval or ratio scale. In this study, we were able to meet this criteria through the availability of interval scaled scores on the comprehension measure we used, the Stanford Diagnostic Reading Test, which made direct score comparison across ages possible (please refer to the Method section for a full explanation).

Study Aims and Hypotheses

In the present research, growth trajectories of reading comprehension during the middle elementary school years, and the determinants of these growth trajectories, formed the bases of study. Data from the fourth to seventh grade was drawn from an existing longitudinal study of children's reading skills, conducted in British Columbia, Canada. Fourth grade was chosen to be the starting point for the study because L1 research suggests that by this time, most children would have made the transition from learning to read, to reading to learn. The study was designed to answer two questions: (a) How similar are ESL learners to L1 learners in their reading comprehension growth trajectories; and (b) How similar are ESL learners to L1 learners in their determinants of their reading comprehension growth trajectories?

With respect to the first question, we were interested in evaluating the equality of several key dimensions of the growth trajectories of ESL and L1 learners. The first related to the form or function of their growth trajectories. As there has not been any prior research to guide a hypothesis, we posed the open question of whether a linear function would best represent growth in reading comprehension in both groups. The second dimension was the initial level of their growth trajectories, that is, fourth grade reading comprehension levels. The expectation was that by this time, ESL learners would have reached similar levels of proficiency in their reading comprehension skills as L1 learners. However, consistent with the findings of existing research, we hypothesized that ESL learners would show lower reading comprehension levels at fourth grade than L1 learners.

The third aspect related to the slope of the growth trajectories, or the rate of growth of reading comprehension skills from the fourth to seventh grade. As there has been no prior research to guide our hypothesis, we were open to three possible outcomes: that ESL learners would show (a) a slower, (b) an identical, and (c) a faster, rate of growth in their reading comprehension skills, than L1 learners.

We addressed the second question by studying the effects of five linguistic determinants of the reading comprehension growth trajectories of ESL and L1 learners measured at fourth grade - phonological awareness, word decoding, word identification, word reading fluency, and grammatical/syntactic awareness skills. Based on L1 bottom-up and top-down theories, we expected all of these skills to be significant predictors of reading comprehension, at least for L1 learners. In the absence of a viable theory on the predictors of reading comprehension in ESL learners, we posed the open question of

whether these variables would exert the same influences on the growth of reading comprehension in ESL learners as for L1 learners. We were open to two possible outcomes – that the influences of these predictor skills would be: (a) identical; and (b) non-identical, across the groups.

METHOD

Participants

Participants for this study were students from fourth to seventh grade from an entire urban school district of 30 schools in North Vancouver, British Columbia, Canada. Vancouver is characterized by a large and rapidly growing immigrant population. As a result, a significant number of students in schools are ESL learners. Most of the ESL learners in this study were immigrants to Canada, although some were born in Canada but did not speak English until they began attending school.

Participants were classified as ESL if they spoke a language other than English at home to parents, siblings, and extended family members. This information was obtained largely through school records and confirmed with classroom teachers and the students themselves. The total number of participants for the study was 1206 (L1=932, ESL=274). Gender was divided equally in this sample. In terms of language background, ESL participants in this study came from a wide variety of linguistic backgrounds, with the full sample including a total of 33 languages. The most frequently spoken first languages were Farsi, Korean, Cantonese, Mandarin, Spanish, Tagalog, and Japanese.

Given that the sample included the full student population of an entire school district, it represented students from a wide range of socioeconomic (SES) backgrounds. The sample was also representative of the wider population demographics of the city of Vancouver, Canada. In addition, given that in this district, ESL and L1 learners live in the neighbourhoods and attend the same schools, this reduced the possibility that the performance of ESL learners would be confounded by SES. The impact of SES on the

literacy outcomes of students in this population was studied in by D'Angiulli and colleagues (D'Angiulli, Maggi, & Siegel, 2004; D'Angiulli, & Siegel, 2004). Their work showed that although there was a correlation between SES and literacy skills in kindergarten, this association decreased significantly by the time the students were in third grade. The researchers attribute this attenuation in the association between SES and literacy skills of the students to the rich literacy program and environment of the North Vancouver school district.

Rich literacy program

All the students participating in this longitudinal study were exposed to a rich literacy learning environment which drew from established reading programs, including Launch Into Reading Success (Ottley & Bennett, 2000), and the North Vancouver school district's own reading curricula and programs, namely, Firm Foundations, and Reading 44. Firm Foundations is a kindergarten level literacy resource developed in the North Vancouver school district that emphasizes the teaching of pre-literacy skills in a play-based format. Reading 44 is a classroom based reading program written by the teachers of the North Vancouver school district designed for use at the K-10 levels. The emphasis on developing early literacy skills was part of the North Vancouver districtwide school policy.

Key components of the literacy program in the North Vancouver school district included explicit teaching of letter sound relationships, building vocabulary and grammar, exposure to story structures, guided reading, content area reading, shared reading, independent reading, reading-writing connection, home reading program, independent reading, literature circles, and read aloud and respond. The literacy program

was delivered through classroom-based, as well as small group activities, by classroom teachers and resource teachers.

In their classroom, children were engaged daily in tasks that provided them opportunities to practice different facets of phonological processing skills such as rhyming, alliteration, explicit manipulation of phonemes, analyzing words into phoneme-sized units, and combining letter sounds into words. Teachers made an effort to balance the levels of systematic and explicit reading instruction with other activities such as reading comprehension and writing activities. Students would retell or discuss or draw about a story read aloud to them by their teacher, for example.

As part of the literacy program, all students were screened in their kindergarten years to identify those children who would be at risk for reading failure. These children received further small group interventions three to four times a week, for 20 minutes at a time, in kindergarten, and four times a week in succeeding grades. The overall structure of the literacy program remained unchanged over the grade levels. ESL students received the same early classroom instruction and intervention in English as their L1 peers.

Measures

The outcome measure or dependent variable, reading comprehension, was assessed through the Stanford Diagnostic Reading Test (SDRT; Karlsen & Gardner, 1994). The SDRT is a group-administered, norm-referenced multiple-choice test that assesses decoding, vocabulary, comprehension, and scanning skills. The SDRT comes in six incremental skill levels targeted at students from end grade 1 through the first semester of college. It takes 30 to 45 minutes to administer.

Students were administered the appropriate levels of the reading comprehension test from the SDRT at every grade from grades 4-7. At each level, students were presented with a booklet containing a series of text passages and multiple-choice questions following each text. A range of text types was used at all levels: recreational reading texts, textual reading texts, and functional reading texts. The multiple-choice questions tapped initial understanding, interpretation, and critical analysis skills. Initial understanding questions measure students' understanding of ideas and relationships that are directly stated in the text. Interpretation questions measure students' abilities to make inferences and predictions, to draw conclusions, and to understand the central ideas in the text. Critical analysis questions require students to evaluate what they have read.

Students were administered the SDRT in groups and required to complete the questions in the booklet within the prescribed time period. The comprehension subtest of the SDRT yields a single composite raw score. A unique feature of the SDRT is the availability of the vertical standard score scale. Raw scores are converted into continuous equal interval scaled scores that span across the full age range of the SDRT. In other words, the SDRT scaled scores are comparable across grades and test levels (Jorgenson,

2004). An increment of 5 points at fourth grade, for example, represents the same amount of change as a similar increment at sixth grade. This continuous and equal interval property of the scaled scores make them an ideal common metric for studying change in reading comprehension over time. Standard scaled scores were used for the analyses.

Predictors

All the predictor variables were measured at the initial time point of the study, that is, fourth grade.

Phonological Awareness. Phonological awareness was measured using the Rosner's Auditory Analysis Test (Rosner & Simon, 1971). This was a task of syllable and phoneme deletion. Students were asked to say a word, and then to say the word again without one of its sounds, for example, they had to say book without the /b/ sound. The task required students to delete syllables, single phonemes from both the initial and final positions of a word, and single phonemes from blends. There were two practice items followed by 40 test items. Items were in increasing order of difficulty. An example of an easy item was to say 'birthday' without the 'day' sound. A more difficult item was to say 'smile without the 's' sound. Children were discontinued after five consecutive errors. Raw scores were used for the analyses.

Word Decoding. Lesaux, Koda, Siegel and Shanahan (2006) emphasized the importance of testing students' abilities to read pseudowords because they provide "insight into basic decoding skills in the absence of meaningful context or memory or words" (p.82). According to these authors, "context-free word recognition is a process that clearly differentiates good and poor readers" (p.82).

Word decoding was measured using the Word Attack subtest of the Woodcock Reading Mastery Test-revised (WRMT-R: Form G: Woodcock, 1989). This task measured students' skills at decoding unfamiliar words. Students were asked to read a set of pseudowords which were arranged in order of ascending difficulty. An example of a simple pseudoword was 'pog', whereas a more difficult pseudoword was 'bafmotbem'. When all items in a given level were failed, students were discontinued. Raw scores were used for the analyses.

Word Identification. Word identification was measured using the Word Identification subtest of the Woodcock Reading Mastery Test-Revised (WRMT-R: Form G: Woodcock, 1989). This test consisted of lists of words of increasing difficulty. Children were asked to read as many words as possible from the list. Discontinuation rules for each test were applied. Raw scores were used for the analyses.

Reading Fluency. Reading fluency was measured by presenting students with a list of real words of increasing difficulty taken from the Wide Range Achievement Test 3 (WRAT3; Wilkinson, 1995) reading subtest, tan form, and asking students to read as many words as possible within a one-minute timed period. The number of words read correctly determined the score for this task. Raw scores were used for the analyses.

Syntactic Awareness. Syntactic awareness was measured with an oral cloze task (Willows & Ryan, 1986; Siegel & Ryan, 1989). The examiner read 11 sentences with a missing word in each sentence to the child. At the missing word, the examiner said "beep". Students were asked to provide a missing word in each sentence. An example was: Jane beep her sister ran up the hill. The student had to say "and". The items in this task tapped six categories of syntactic knowledge: (1) past tense: regular and irregular

forms, (2) comparative and superlative items, (3) conjunctions, (4) prepositions, (5) pronouns, and (6) past participles. The entire test can be found in Appendix A. Raw scores were used for the analyses.

Data Collection

Participants were tested yearly, together, during their spring terms, by trained graduate students from the University of British Columbia. Each year new students were invited to participate in the study. All participants had parental consents and also provided student assents. Each student sat for an individual session and a group session. Apart from the Stanford Diagnostic Reading Test which was group administered, all other tests were administered individually. All tests were administered in the same order.

RESULTS

Analyses

Latent growth modeling (LGM) via the statistical software, Mplus (fourth edition; Muthen & Muthen, 1998-2007) was used for the entire analyses. Figure 2.1 illustrates the general unconditional latent growth model (LGM) used in addressing the first question. In the figure, squares denote observed variables, circles, latent variables. The four squares represent the four waves of observed reading comprehension data from fourth to seventh grade, RC4-RC7. The two latent factors, F1 and F2, represent Intercept and Slope, respectively. Intercept represents the collection of individual scores at fourth grade that characterize the initial values of each individual's growth curve, with the mean represented by Mi, and the variance represented by Di. As Intercept is a constant for any individual across time, fixed values of 1 are given for the path coefficients across all four repeated measures.

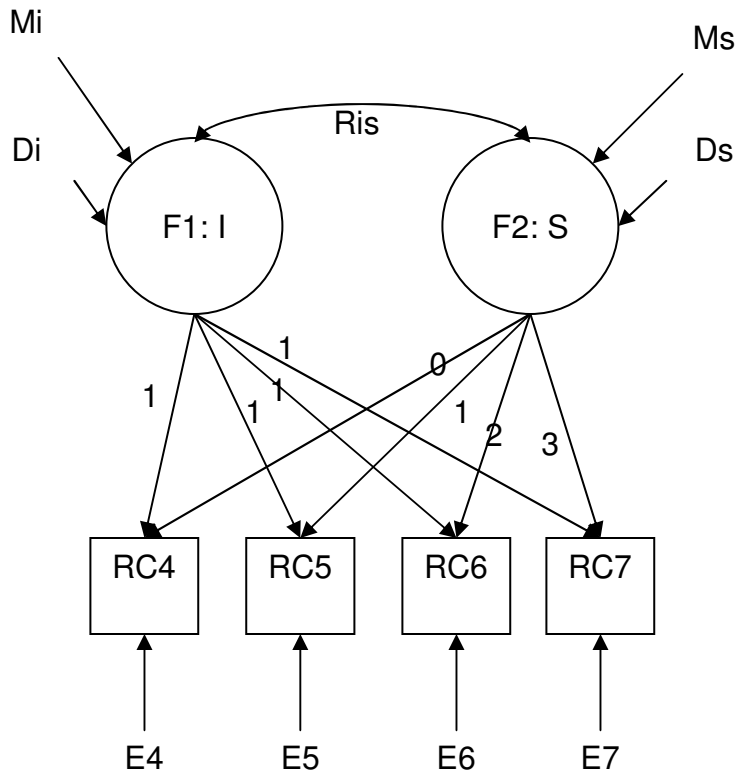

Figure 2.1. Representation of the unconditional latent growth model

The second factor, Slope, represents the collection of individual slopes or trajectories that are determined by the repeated measures from fourth to seventh grade, with mean Ms, and variance Ds. Unlike the path coefficients of Intercept, which are fixed at 1, path coefficients for Slope are fixed at 0, 1, 2 and 3, in order, to represent a linear growth trend in reading comprehension from fourth to seventh grade. Intercept and Slope are allowed to covary, with the covariance indicated by Ris, shown by the double-headed arrow between the two factors. Finally, the labels E4-E7 represent the error variance at each repeated measure.

Figure 2.2 represents the general conditional LGM used in the second question, with the addition of four squares representing four observed predictor variables, P1-P4. The effects of each of these predictors on each of the Intercept and Slope are measured via their respective beta weights. With the addition of predictor variables into the model, Mi and Ms now represent that part of the factor mean that is not explained by the additional predictor variables; similarly, Di and Ds now represent that part of the factor variance that is not explained by the additional predictor variables.

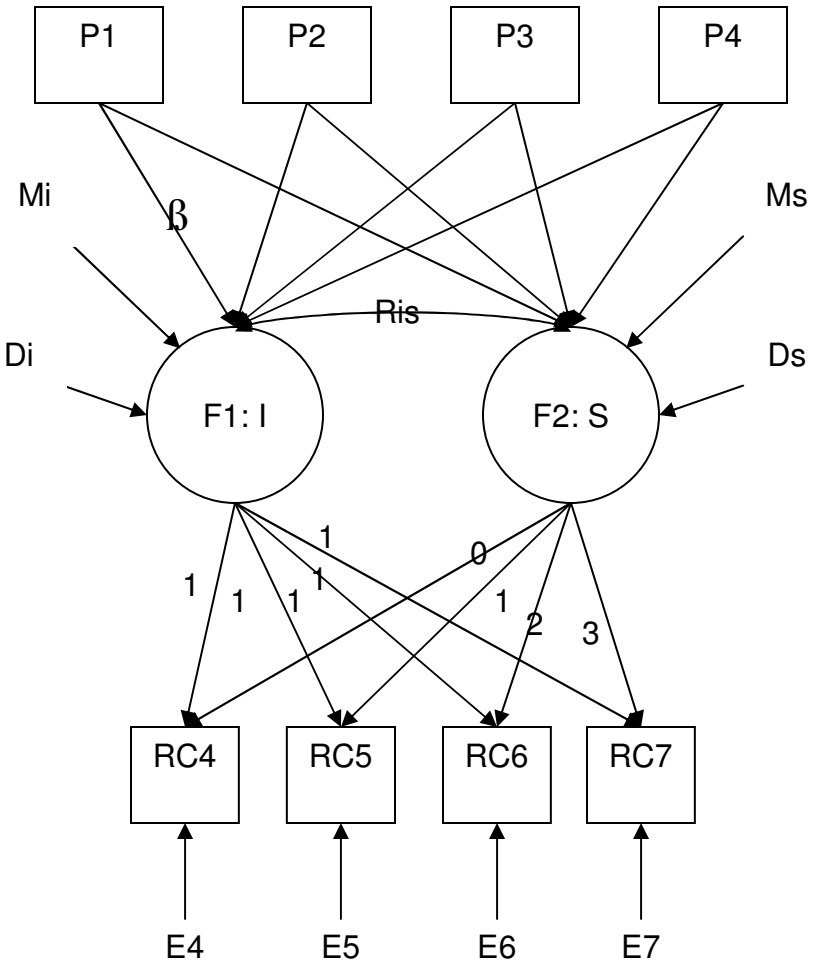

Figure 2.2. Representation of the conditional latent growth model

The first question (similarity of growth trajectories) involved carrying out a series of multiple-group LGMs of the unconditional growth models of the L1 and ESL groups; the second question (similarity of predictors of the growth trajectories) involved multiple-group LGMs of the conditional growth models of the two groups. The estimator used throughout the analyses was maximum likelihood (ML) analysis. Multiple-group LGM

is a specialized LGM procedure which allows researchers to simultaneously model and compare the growth trajectories of different populations provided the outcome measures are the same across groups. Multiple-group LGM is performed by fitting an ordinary LGM in each group, but doing so simultaneously for all groups. Then, by specifying equality constraints on specified growth parameters, multiple-group LGM allows investigators to test for equality, or measurement invariance, of the specified growth parameters across groups. In other words, multiple-group LGM allows the researcher to determine whether a common developmental pathway exists across groups, or whether there are multiple pathways across groups (Duncan, Duncan, & Stryker, 2006).

Absolute model fit was evaluated via several fit indices (Hu & Bentler, 1995, 1999). CFI (Comparative fit index) and TLI (Tucker-Lewis Index) are comparative fit indices. A CFI or TLI value close to 1 signifies a very good fit (Hu & Bentler, 1995). By convention, a CFI or TLI value of above .9 indicates an acceptable fit, while a value of less than .9 indicates a need to re-specify the model. A third index, RMSEA (root mean square error of approximation) is an index of relative fit. An RMSEA value of less than .08 signifies a good fit, of between .08 and .1 an adequate fit, and of more than .1, a poor fit (Hu & Bentler, 1999). Although chi-square statistics are reported, they were not used in evaluating absolute model fit due to the sensitivity of this statistic to sample sizes.

Three fit indices were used for comparing model fit across models. AIC (Aikike information criterion) and BIC (Bayes information criterion) are parsimony-based indices used solely for model fit comparison. The lower the AIC or BIC values, the better the model fit. In the special case where one model is nested within another, the chi-square difference statistic can additionally be used to evaluate the better model fit. In this study,

chi-square difference testing was used for measurement invariance testing of growth parameters of the growth trajectories of L1 and ESL learners. The procedure for testing parameter invariance across groups essentially involves imposing cross-group constraints on individual parameters or sets of parameters, then comparing these restricted models to the less restricted model using the chi-square difference statistic. This step involves subtracting the chi-square value and degrees of freedom of the less restrictive model from the corresponding values of the nested, more restrictive model. The chi-square difference value is compared to the chi-square value in a chi-square table using the difference in degrees of freedom between the more restrictive and less restrictive models. A significant chi-square difference indicates that constraining the parameter(s) of the nested model significantly worsened the fit of the model. This indicates measurement non-invariance of the parameter(s) constrained to be equal in the nested model. A non-significant chi-square difference indicates that constraining the parameter(s) of the nested model did not significantly worsen the fit of the model. This indicates measurement invariance of the specified parameter(s).

Missing Data

At each grade level, missing data ranged from 9% to 23%. An advantage of the software used in this study, Mplus, is its flexible options for estimating growth models with missing data. Mplus provides maximum likelihood (ML) estimation under MCAR (missing completely at random) and MAR (missing at random) for continuous data. In this study, missing data was primarily the result of student attrition, and assumed to be MCAR.

Only cases with complete data were included in the analysis through a process of listwise deletion. This resulted in a final working sample of 746 students (L1=593, ESL=153). In order to check for the effect of missing data, the entire analysis was repeated using all 1206 participants to see if results would be different. Overall results were unchanged, which provided further validation for the study.

Question 1: Equality of Unconditional Growth Models

As no a-priori hypothesis exists on the growth form of reading comprehension skills, scatterplots and means plots of overall and group reading comprehension scores were first examined for likely growth forms. Observed data suggested that a linear function was a likely fit for the data (see Figure 2.3). Goodness of fit indices corresponding to an unconditional linear model for the overall dataset were as follows: $\chi 2(5)=41.45$, $p<.0001$, AIC=28079, BIC=28121, CFI=.98, TLI=.98, RMSEA=.099.

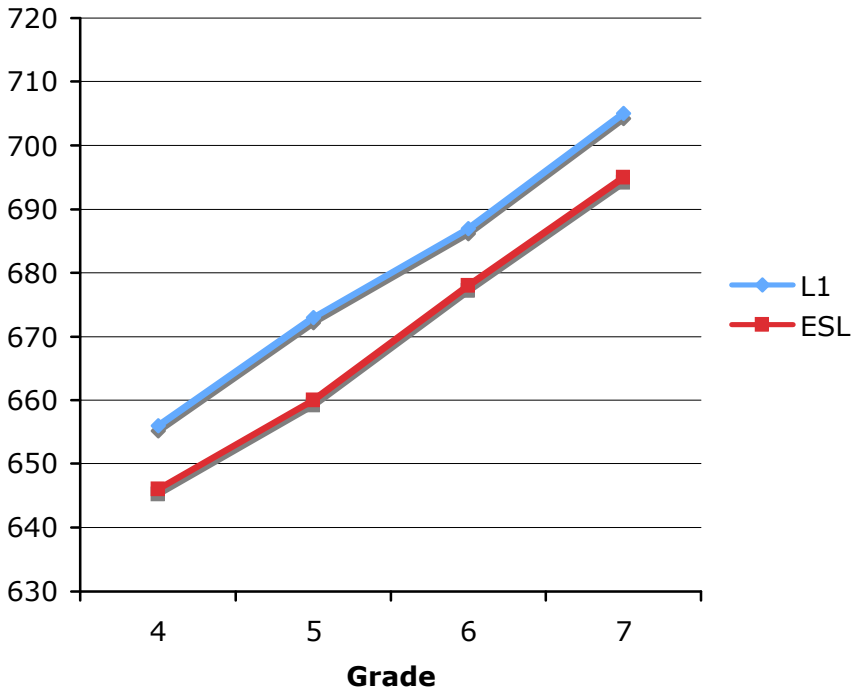

Figure 3.3. Observed means plot of reading comprehension scores of L1 and ESL groups

The linear model was subsequently compared with a non-linear model by fitting a second model for the overall dataset with freed time scores: $\chi 2(3)=37.85$, $p<.0001$, AIC=28080, BIC=28131, CFI=.98, TLI=.96, RMSEA=.125. Chi-square difference between the linear and non-linear models was non-significant, $\chi 2(2)=1.8$, indicating that freeing the path coefficients did not improve the fit of the original (linear) model. AIC and BIC scores were lower for the linear than non-linear model, further favouring a linear fit for the overall data. The linear trend was therefore used for all further analyses.

To address the first research question, a multiple-group LGM (L1 and ESL groups) was conducted, testing for equality or measurement invariance of key growth

parameters between groups. The following invariance hypotheses were tested: (a) equality of path coefficients (growth function); (b) equality of factor (Intercept and Slope) means; (c) equality of factor variances; (d) equality of error variances and covariances; and (e) equality of all parameters. Duncan, Duncan, and Stryker (2006) recommend including the first three invariance hypotheses when evaluating equality of LGMs. Although these researchers consider hypothesis (d), equality of error variances and covariances, to be the least important hypothesis to test, this hypothesis was nevertheless added to the analyses for completeness. The final hypothesis (e), equality of all parameters, is considered the most restrictive of all hypotheses, as it implies that both first moments (means) and second moments (variances and covariances) are equal. This hypothesis was to be tested if the individual parameters in the previous hypotheses tested to be equal.

The multiple-group unconditional LGM is depicted in Figure 2.4. Descriptive statistics and covariance matrices for the two groups, L1 learners (N=593) and ESL learners (N=153), are provided in Table 2.1. There are two key acceptable approaches to test for parameter invariance across groups, depending on the nature of the hypotheses (Duncan et al., 2006). One approach is to start with a fully constrained model and allow individual or sets of parameters to be free. The predominant approach used in this study was to start with a fully unconstrained model, then impose constraints on individual or sets of parameters.

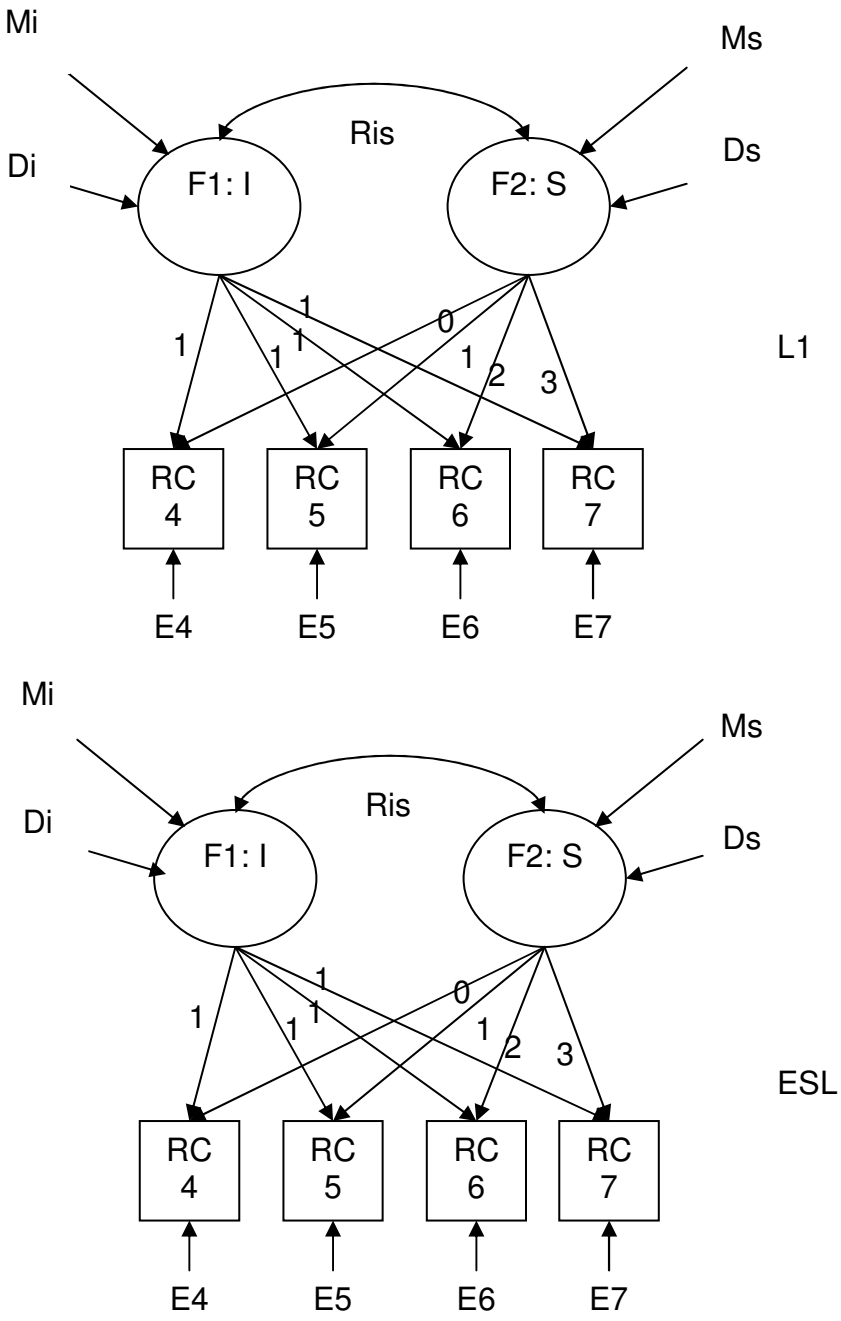

Figure 2.4. Representation of the multiple-group unconditional LGM

Table 2.1 Descriptive statistics for the multiple-group unconditional LGM

	Reading Comprehension			
	RC4	RC5	RC6	RC7
L1 (N=593)	1029.3			
	640.6	951.7		
	816.2	789.6	1405.6	
	839.7	762.0	1093.5	1572.9
Mean (SD)	656.4 (32.08)	673.1 (30.85)	686.7 (37.49)	704.9 (39.66)
ESL (N=153)	1324.6			
	942.1	1266.3		
	1071.9	926.8	1544.8	
	1090.3	948.3	1312.6	1741.1
Mean (SD)	646.2 (36.40)	660.4 (35.59)	678.0 (39.30)	695.4 (26.37)

Note. Variances are in the diagonals, covariances are in the subdiagonals.

Model fitting with a linear trend and all parameters unconstrained across both groups resulted in the following fit indices: $\chi 2(10)=48.08$, $p<.0001$, AIC=28068, BIC=28151, CFI=.98, TLI=.97, RMSEA=.101. This model served as the 'baseline' model against which subsequent modified models were compared to test the different invariance hypotheses.

Testing equality of path coefficients

The first modified multiple-group LGM was created in which path coefficients for the third and fourth waves were allowed to be free across groups. This modified model resulted in the following fit indices: $\chi 2(8)=44.79$, $p<.0001$, AIC=28069, BIC=28161, CFI=.98, TLI=.97, RMSEA=.11. Chi-square difference between this and the baseline, fixed, linear model was non-significant, $\chi 2(2)=1.65$, signifying measurement invariance of path coefficients. AIC and BIC values favoured the baseline model, in which the growth trajectories for both groups were fixed to be linear.

Testing equality of factors means

Equality of Intercept means, Mi, and Slope means, Ms, were tested separately. A modified model with Intercept means constrained to be equal across groups yielded the following fit indices: $\chi 2(11)=60.14$, $p<.0001$, AIC=28078, BIC=28157, CFI=.97, TLI=.97, RMSEA=.11); the corresponding model with Slope means constrained to be equal yielded the following fit indices: $\chi 2(11)=48.42$, $p<.0001$, AIC=28066, BIC=28145, CFI=.98, TLI=.98, RMSEA=.095). In comparing each of the modified (nested) models with the baseline model, only the chi-square difference for the model with unconstrained Intercept means was significant, $\chi 2(1)=12.06$, $p<.001$. In other words, constraining this

parameter of the nested model significantly worsened the fit of the model, indicating measurement non-invariance of Intercept means across groups. A non-significant chi-square difference was obtained with the constrained Slope means model, $\chi 2(1)=.34$, ns, indicating measurement invariance of Slope means across groups.

Testing equality of factor variances

Equality of Intercept variance, Di, and Slope variance, Ds, were similarly tested separately. The nested model with Intercept variance constrained to be equal across groups yielded the following fit indices: $\chi 2(11)=56.37$, $p<.0001$, AIC=28074, BIC=28153, CFI=.97, TLI=.97, RMSEA=.11; the corresponding model with Slope variance constrained to be equal yielded the following fit indices: $\chi 2(11)=49.95$, $p<.0001$, AIC=28068, BIC=28146, CFI=.98, TLI=.98, RMSEA=.10). Only the chi-square difference between the model with constrained Intercept variance and the baseline model was significant, $\chi 2(1)=8.29$, $p<.005$, indicating measurement non-invariance of Intercept variance across groups. Chi-square difference for the model with constrained Slope variance was non-significant, $\chi 2(1)=1.87$, ns, indicating measurement invariance of Slope variance.

Testing equality of error variances and covariance

The nested model with error variances, E, and covariance, Ris, constrained to be equal across groups yielded the following fit indices: $\chi 2(15)=56.75$, $p<.0001$, AIC=28067, BIC=28127, CFI=.97, TLI=.98, RMSEA=.086). Chi-square difference between this and the baseline model was non-significant, $\chi 2(5)=1.73$, indicating measurement invariance in these parameters across groups.

To summarize the above findings, two key growth parameters were found to be non-invariant, or unequal, across the ESL and L1 groups – Intercept mean, and Intercept variance. All other growth parameters – path coefficients (linear function), Slope mean, Slope variance, error variance and covariance, were found to be invariant, or equal, across groups.

Final specification of the unconditional multiple-group LGM

In seeking the most parsimonious multiple-group LGM for the data, three potential multiple-group LGMs, created based on the results of the above invariance testing, were evaluated for best fit: a linear multiple-group model with (a) Intercept means unconstrained, all other parameters constrained across groups; (b) Intercept variance unconstrained, all other parameters constrained across groups, and (c) Intercept mean and Intercept variance unconstrained, all other parameters constrained across groups. Model (c) yielded the lowest AIC, BIC, and RMSEA values, fit indices: $\chi 2(17)=57.17$, $p<.0001$, AIC=28063, BIC=28079, CFI=.98, TLI=.98, RMSEA=.08. This third model, with Intercept mean and Intercept variance unconstrained, all other

parameters constrained across groups, thus represented the final unconditional multiple-group LGM for the data, with parameter values specified in Table 2.2.

Table 2.2 Final unconditional multiple-group LGM parameters

	Estimate	SE	t-value
Intercept mean			
L1	656.38	1.21	541.05*
ESL	645.62	2.71	238.66*
Intercept variance			
L1	642.58	53.85	11.93*
ESL	910.90	129.11	7.06*
Slope mean	16.01	.36	43.97*
Slope variance	25.37	7.29	3.48*
Covariance	43.50	14.10	3.09*
Error variance			
E4	321.45	32.16	10.0*
E5	383.79	25.43	15.09*
E6	369.53	26.39	14.01*
E7	419.24	40.21	10.43*

* $p<.05$

To summarize, in the final unconditional multiple-group LGM, Intercept was significant and different for L1 and ESL learners. Significance implies a non-zero intercept value. In this final model, L1 learners' average reading comprehension scores at fourth grade, Mi=656.38, t=541.05, was significantly higher than ESL learners' average score, Mi=645.62, t=238.66. Next, Intercept variance was also significant and different for both groups. A significant Intercept variance signifies substantial and significant variability in initial scores across individuals. This variability was also different in both groups.

Apart from the above parameters, all other parameters were found to be significant and equal across groups. In other words, no further group differences were detected. A significant slope mean indicates positive growth. Both groups showed a growth rate of 16.01 scaled score points per year (t=43.97) in reading comprehension scores between the fourth to seventh grade. A significant slope variance indicates substantial and significant variability in the growth trajectories in both groups. This variability was identical for both groups.

Finally, a significant and positive covariance value indicates that higher values on Intercept are associated with higher values on Slope, and vice versa; again this pattern was identical for both groups. The final expected growth trajectories of reading comprehension for the L1 and ESL groups are illustrated by two straight, ascending, and parallel lines, with the higher line representing L1 growth trajectories, as shown in Figure 2.5.

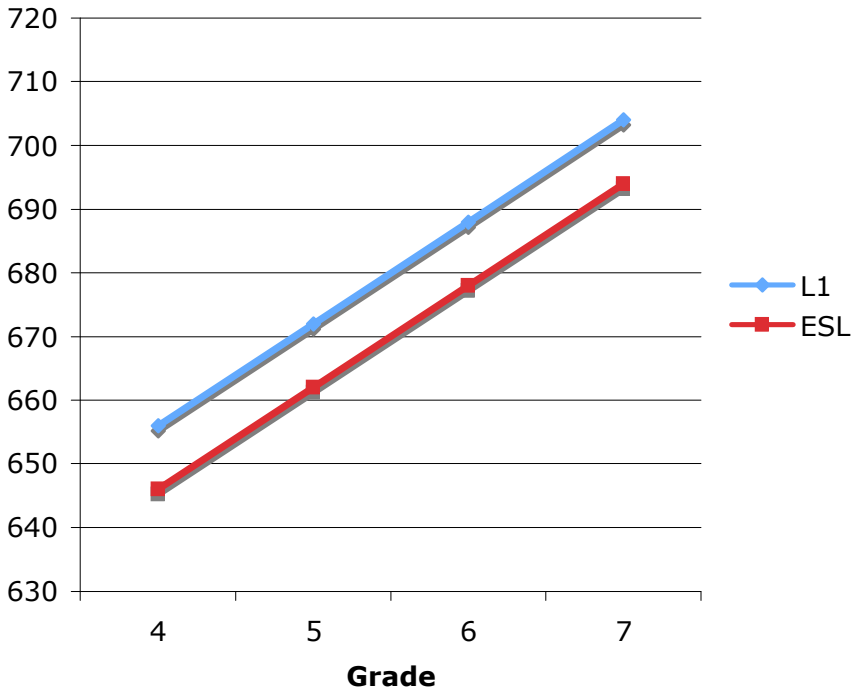

Figure 2.5 Expected growth trajectories of reading comprehension for L1 and ESL groups based on the final model

Question 2: Equality of Conditional Growth Models

We first tested a linear conditional growth model with the overall sample (N=743) with all original five predictors in, to study the overall effects of the predictors on reading comprehension growth. This model produced the following fit indices: CFI=.98, TLI=.96, RMSEA=.065, AIC=46991, BIC=47079. Together, the predictors accounted for 46.6% of the variance in Intercept, and 7.7% of the variance in Slope. Of the five covariates, four were significant for either Intercept or Slope - Word Decoding, Word Identification, Reading Fluency and Syntactic Awareness. The fifth predictor, Phonological Awareness, was not significant for Intercept nor Slope.

In an attempt to reach a more parsimonious model amongst the pool of predictors, a further model was tested with the non-significant covariate, Phonological Awareness, excluded. With phonological awareness removed, fit indices were as follows: CFI=.98, TLI=.96, RMSEA=.069, AIC=42447, BIC=42525. Compared with the model with the full set of (five) predictors, AIC and BIC values were lower, favouring a conditional model without the predictor Phonological Awareness. No significant drop in the variance in Intercept or Slope explained was observed with the omission of Phonological Awareness - the remaining covariates (Word Decoding, Word Reading, Reading Fluency and Syntactic Awareness) accounted for 46.5% of the variance in Intercept (compared with 46.6%), and 6.8% of the variance in Slope (compared with 7.7%). Phonological Awareness was therefore excluded from further analyses.

To address the second research question, a multiple-group conditional LGM (L1 and ESL groups) was conducted with four covariates included - Word Decoding, Word Reading, Reading Fluency and Syntactic Awareness, with the aim of testing for

measurement invariance of parameters across groups. This model is illustrated in Figure 2.6. Descriptive statistics are in Table 2.3. Duncan et al. (2006) recommend testing for equality of regression coefficients as a way of evaluating the equality of causal processes in multiple-group growth analyses. Two invariance hypotheses were tested – (a) equality of regression coefficients, and (b) equality of all parameters.

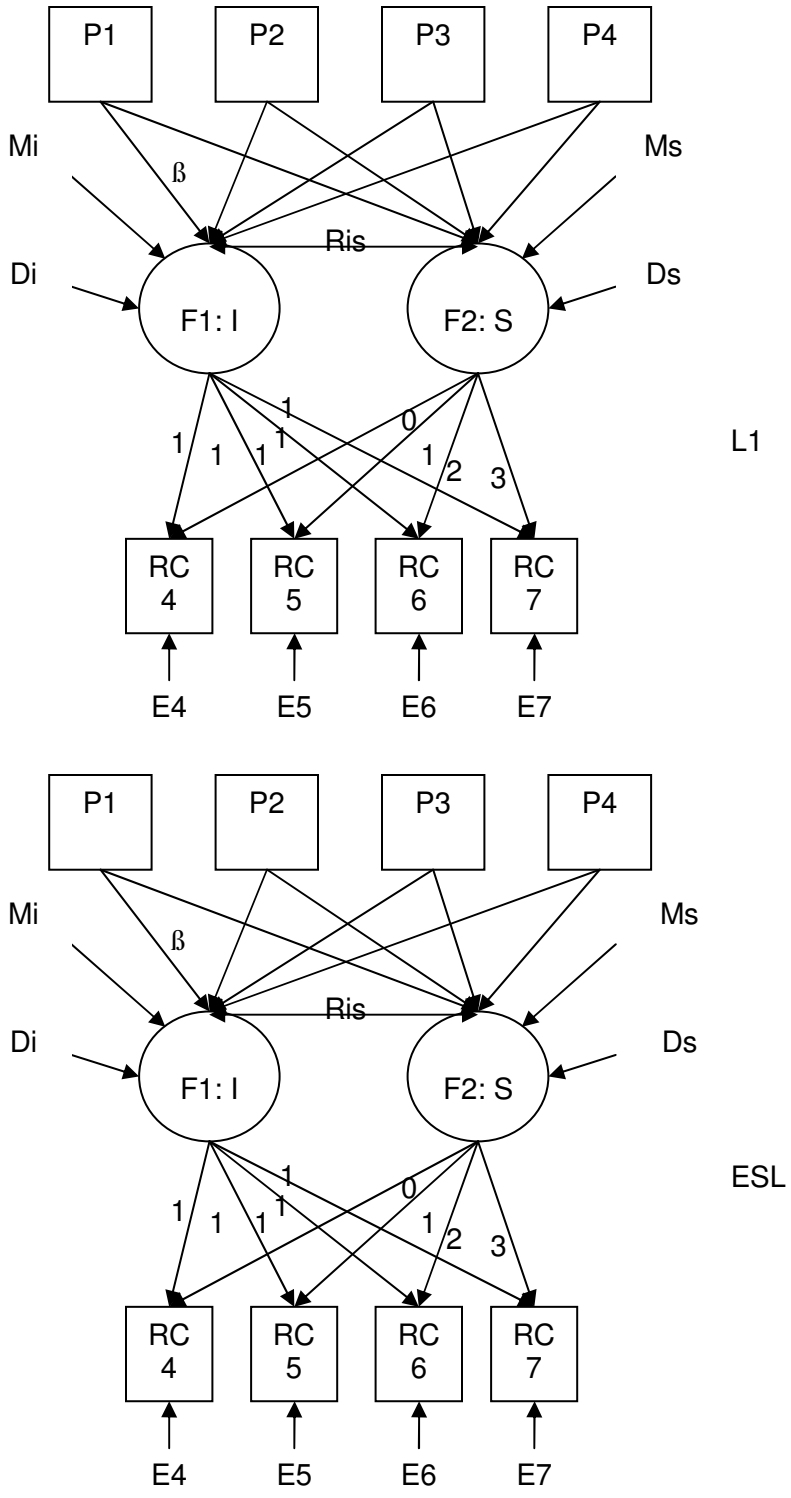

Figure 2.6 Representation of the multiple-group conditional LGM

Table 2.3 Descriptive statistics for the multiple-group conditional LGM

	Phonological Awareness	Word Decoding	Word Identification	Reading Fluency	Syntactic Awareness
L1 (N=593)					
	37.04				
	.52	23.66			
	.47	.75	21.38		
	.41	.69	.76	25.78	
	.32	.25	.32	.29	1.82
Mean (SD)	31.92 (6.09)	21.87 (4.86)	44.36 (6.66)	21.58(5.08)	8.67 (1.35)
ESL (N=153)					
	44.50				
	.61	27.65			
	.54	.76	21.01		
	.53	.76	.81	24.85	
	.30	.36	.42	.34	3.93
Mean (SD)	30.86 (6.67)	21.40 (5.26)	44.07 (4.58)	21.35 (4.98)	7.77 (1.98)

Variances are in the diagonals, correlations are in the subdiagonals

Model fitting with all parameters unconstrained resulted in the following fit indices: $\chi 2(26)=73.48$, $p<.0001$, AIC=42355, BIC=42512, CFI=.98, TLI=.96, RMSEA=.070. This served as the baseline model for testing the invariance hypotheses.

Testing for equality of regression coefficients

A modified multiple-group LGM was created with regression coefficients of all four covariates constrained to be equal across groups. This nested, more restrictive model yielded the following fit indices: $\chi 2(34)=86.55$, $p<.0001$, AIC=42352, BIC=42472, CFI=.98, TLI=.97, RMSEA=.064. Chi-square difference between this and the baseline model was not significant, $\chi 2(8)=1.63$, ns, signifying measurement invariance of the constrained parameters across groups. AIC and BIC values were lower for the more restrictive model, further confirming equality of regression coefficients across groups.

Testing for equality of all parameters

Next, a nested model with all parameters constrained to be equal, yielded the following fit indices: $\chi 2(43)=102.1$, $p<.0001$, AIC=42350, BIC=42428, CFI=.97, TLI=.97, RMSEA=.061. Chi-square differences between this and the baseline model was also non-significant, $\chi 2(17)=1.60$, ns, indicating measurement invariance of all parameters across groups. AIC and BIC values were lower for the fully restricted model than either the baseline model or the model with (only) regression coefficients constrained, suggesting that this model, with all parameters constrained, represented the most parsimonious multiple-group conditional LGM for the data.

Final specification of the conditional multiple-group LGM

The final multiple-group LGM was re-specified with four predictors – Word Decoding, Word Identification, Reading Fluency, and Syntactic Awareness, and all parameters constrained to be equal across both groups. Model parameters for this final model are specified in Table 2.4. To summarize, the conditional LGMs were identical in both groups. For both groups, Word Identification, Reading Fluency, and Syntactic Awareness, were significant predictors of initial reading comprehension at fourth grade; Word Decoding was not a significant predictor of initial reading comprehension scores. In other words, higher scores on Word Identification, Reading Fluency, and Syntactic Awareness, but not on Word Decoding, were associated with higher reading comprehension scores for both groups.

Table 2.4 Final multiple-group conditional LGM parameters

	Estimate	SE	t-value
Regression effects on Intercept			
WD	-.52	.29	-1.77
WI	2.47	.35	7.03*
RF	.79	.30	2.68*
SA	6.32	.63	10.04*
Regression effects on Slope			
WD	-.23	.12	-1.96*
WI	.42	.14	3.05*
RF	.02	.12	.16
SA	.03	.25	.13
Covariance	15.64	12.53	1.25
Residual variance			
Intercept	392.69	36.73	10.69*
Slope	26.72	7.05	3.79*

* $p < .05$

WD: Word Decoding; WI: Word Identification; RF: Reading Fluency; SA: Syntactic Awareness

For both groups, only initial Word Decoding and Word Identification scores predicted the growth trend of reading comprehension from fourth to seventh grade. Word Decoding predicted reading comprehension growth negatively, indicating that higher Word Decoding scores were associated with lower growth trends, and vice versa. Initial Word Identification was a positive predictor of reading comprehension growth, indicating that higher word reading scores were associated with steeper growth trajectories. Together, the predictors accounted for 44% of the variance in Intercept, and 6.9% of the variance in Slope, for L1 learners. For ESL learners, they accounted for 52.9% of the variance in Intercept, and 6.5% of the variance in Slope.

Because Phonological Awareness was dropped from the original pool of predictors based on analyses conducted with the overall sample, the entire analysis was repeated with Phonological Awareness included among the predictors. Results showed that phonological Awareness was not significant for Intercept nor Slope, for any model tested, for L1 nor ESL group. Overall results remained unchanged, that is, the best fitting model was still the model with all parameters constrained to be equal across groups.

DISCUSSION

This research investigated the developmental pathways or trajectories of reading comprehension, and the determinants of these pathways in ESL and L1 learners over the middle elementary school years. Two research questions provided the focus for the investigation: (1) How similar are ESL learners to L1 learners in their reading comprehension growth trajectories? (2) How similar are ESL learners to L1 learners in their determinants of reading comprehension growth? By including a reference group of native English speakers in this study, and comparing ESL learners directly against this group on the investigated growth attributes, we were able to address not just the question of how reading comprehension develops in ESL learners, but how closely matched this developmental process is to L1 learners. Ultimately, we hoped to address the question of how generalizable L1 models of reading comprehension are to ESL learners.

Addressing the first research question, the results from the unconditional growth analyses showed a high level of similarity between ESL and L1 learners in the way their reading comprehension skills grow and change over the middle elementary school years. For one, growth in reading comprehension from the fourth to seventh grade takes a linear form in both ESL and L1 learners. Two, ESL learners make the same incremental gain in their reading comprehension skills (16 scaled scores on the Stanford Diagnostic Reading Test) as L1 learners each year. Three, they manifest the same intra-individual variability in their growth trajectories as L1 learners. Because both groups were exposed to the same instructional environments over the period of study (i.e. both groups attended the same schools and classes, and received the same instruction and interventions), we can further infer that ESL learners are similar to L1 learners in their responses to (reading)

instruction, at least in terms of the form and growth rates of their reading comprehension trajectories.

In terms of the determinants of the reading comprehension growth trajectories of ESL and L1 learners, the results from conditional growth analyses showed full correspondence between the growth models of the two groups. In other words, the impact of the investigated linguistic predictors – phonological skills, pseudoword decoding, word identification, word reading fluency, and syntactic awareness, on the reading comprehension growth trajectories, was identical for both groups. Not all the predictors were significant, however. Only word identification skills, as measured by an untimed real word reading task, was a significant predictor for both initial reading comprehension level (at fourth grade) and reading comprehension growth (from fourth to seventh grade), for both groups. Reading fluency, as measured by a timed real word reading task, and syntactic awareness, as measured by an oral cloze task, were both significant predictors of initial reading comprehension levels, but not reading comprehension growth. On the other hand, phonological skills, as measured by a phoneme and syllable deletion task, as well as word decoding, measured by a pseudoword reading task, played no significant roles for either initial reading comprehension levels at fourth grade, or growth in reading comprehension from fourth to seventh grade.

The pattern of significant predictor results suggests that competencies of real word reading, reading fluency, and knowledge of grammatical and syntactical features of text, matter, for both L1 and ESL learners, in their development of reading comprehension in the middle elementary school years. In addition, they matter equally

for both groups. The results showed that together, word reading, reading fluency, and syntactic awareness, accounted for roughly half of the variance in the Intercept (initial scores), and about 7% of the variance in the Slope (growth), of the reading comprehension trajectories for both groups.

The pattern of non-significant predictor results warrants some discussion. First, the finding of a non-significant effect of phonological awareness on the reading comprehension growth trajectories is not inconsistent with the literature. Although studies have shown that early phonological skills account for a significant amount of variance in reading comprehension in grades 1 and 2 (Gottardo, Stanovich & Siegel, 1996; Juel, Griffith & Gough, 1986; Torgeson, Wagner, Rashotte, Burgess, & Hecht, 1997), more recent studies suggest that this relationship may not be a direct one (Perfetti, Landi, & Oakhill, 2005). L1 studies using methods such as structural equation modeling suggest that the relationship between phonological skills and reading comprehension may be an indirect one that is mediated by word recognition (Cain, Oakhill & Bryant, 2000).

Meschyan (2002) investigated the relationship between phonological skills and reading comprehension within an ESL population. Their study sample was composed of fourth and fifth grade Spanish speaking children learning English as an additional language. Meschyan (2002) found that as with L1 learners, a model in which phonological skills facilitated reading comprehension indirectly through its direct effects on word decoding and vocabulary, was superior to other tested models.

Next, the lack of a direct impact of word decoding skills on reading comprehension growth, in the presence of other word and text related predictor skills, is also consistent with the literature. Researchers have generally found a word decoding by

linguistic comprehension skills interaction for beginning versus proficient readers. L1 studies have shown that while word decoding explains a large portion of variance in reading comprehension in the early grades (grades 1-2), this correlation decreases rapidly with increasing grade levels as vocabulary and listening comprehension take on increasingly larger roles in explaining reading comprehension at the upper grade levels (Gough, Hoover, & Peterson, 1996; Hoover & Gough, 1990; Joshi, Williams, & Wood, 1998; Tunmer & Hoover, 1992; Verhoeven and van Leeuwe, 2008).

This pattern has also been found with ESL learners. In his work with first and second grade Turkish speaking students learning Dutch, Verhoeven (1990; 2000) demonstrated that by the second grade, the explanatory power of word reading had decreased while the influence of oral proficiency skills had increased. It is therefore not implausible that by the fourth grade, word decoding skills no longer played a significant role in the development of reading comprehension in the relative presence of more developed reading skills such as real word reading, reading fluency, and knowledge of the grammatical and syntactical structures of the English language.

In sum, extensive developmental parallels exist between ESL and L1 learners in the way their reading comprehension skills develop and grow that suggest that a common model might apply to both groups. ESL learners are identical to L1 learners in the form and shape of their reading comprehension growth curves, slope of their growth curves, intra-individual variability of their growth curves, and the linguistic determinants of their growth curves. Growth in reading comprehension is linear for both groups, and supported by the same basic linguistic processes (word reading, reading fluency, and syntactic awareness). Given the same learning environment, ESL and L1 learners

respond to instruction in the same ways, by making the same annual gains in reading comprehension.

These findings offer compelling support for the generality of L1 models of reading comprehension to ESL populations. Educators can expect ESL learners in their classrooms to develop reading comprehension skills in the same way and at the same rate as L1 learners. They can also expect that as for their L1 learners, boosting the reading accuracy and fluency skills, and the level of syntactic awareness levels of ESL learners, will have a direct and positive impact on their reading comprehension skills.

The study found one significant difference in the reading comprehension growth trajectories of ESL learners compared with L1 learners. Consistent with the study hypothesis, ESL learners showed significantly lower initial (fourth grade) reading comprehension scores (M=645.6, SD=33.52) than L1 learners (M=656.4, SD=29.47). Calculation of the effect size of the statistical difference using Cohen's d suggested that this difference is of practical concern, d=1.37. The 10-point scaled score discrepancy is small however. It is noted that the average reading comprehension score for ESL learners fell within the range of a single standard deviation of the corresponding score for L1 learners. We further determined the corresponding reading comprehension percentile scores of L1 (M=53.58, SD=23.72) and ESL learners (M=46.12, SD=24.55) at fourth grade. In other words, though lagging behind their L1 peers, the reading comprehension skills of ESL learners are in fact well within the normative "average" range of skills.

An important follow up question was whether ESL learners closed this initial gap in reading comprehension over time. The results of this study suggest that they did not do so. As there were no slope differences detected in the trajectories of the two groups,

this implied that the initial gap in reading comprehension remained constant over time, that is, it neither increased nor decreased. The visual representation of this developmental distinction is one of two parallel ascending lines (see Figure 2.5), the higher line representing the developmental trajectory of reading comprehension in L1 learners, the lower line, the corresponding trajectory for ESL learners. Essentially, ESL learners are growing at the same rate, and in the same way (linear), as their L1 counterparts in their reading comprehension skills, but at a lower skill level.

One possible explanation for the relatively weaker reading comprehension skills of ESL learners in comparison to L1 learners is that ESL learners may possess skill deficits in one or more of the basic processes underlying their reading comprehension growth trajectories. In this study, three basic processes were found to be significant for reading comprehension growth in both ESL and L1 learners – word reading, reading fluency, and syntactic awareness. Follow up testing of the difference of means between the two groups on each of these significant covariates revealed that at fourth grade (initial time point), ESL learners showed a significant and sizable deficit in syntactic awareness skills compared with L1 learners, $t(294)=6.42$, $p<.0001$, $d=.53$. There were no other group differences, that is, ESL learners were equal to L1 learners in the other critical basic processes of word reading and reading fluency. The finding of deficits in the structural and grammatical aspects of the English language in ESL learners in the face of comparable word reading skills, has been found consistently in the literature (e.g. Lesaux et al., 2006). It appears that while growth in reading comprehension is influenced by the same basic processes in both ESL and L1 learners, ESL learners may possess deficits in one or more of these processes that have the effect of depressing their overall reading

comprehension skills attainment, without necessarily retarding reading comprehension skill growth.

Specific features in the study may potentially limit the generality of the study findings, such as study sample, study measures, and choice of predictor variables. The sample used in this study was an entire school district in the city of Vancouver. While it was therefore representative of the wider school and ESL population in Vancouver and other similar cities in Canada, only further replication studies conducted with ESL populations living in different countries, and from different language backgrounds, can inform the field as to the generality of these growth patterns across all ESL learners.

This study did not break down the subskills of reading comprehension. It is possible that the developmental trajectories of ESL learners may compare differently to L1 learners as a function of different comprehension subskills, for example, literal comprehension versus inferential, or predictive, comprehension skills. Replication studies need to include different measures of reading comprehension, and particularly measures that tap into the specific subskills and processes of reading comprehension.

A substantial portion of the variance in the reading comprehension growth trajectories remained unaccounted for by the present set of predictor variables. Significant values in the Intercept and Slope variance parameters in the final conditional growth model further confirm that substantial variability exists in these parameters that could be accounted for by predictors not included in the study. Recall that both bottom-up, namely, basic word processes, and top-down, namely text and comprehension-related processes, are critical in the development of reading comprehension (e.g. Hoover and Gough, 1990). Most of the predictor variables available for this study fell under "bottom-

up" processes, with only the predictor of syntactic awareness belonging under the category of a "top-down" process. In separate studies, large correlations have been demonstrated between vocabulary size and reading comprehension (Bast & Reitsma, 1998; Muter, Hulme, Snowling, & Stevenson, 2004; Torgeson, Wagner, Rashotte, Burgrss, & Hecht, 1997; Verhoeven, 2000), and listening comprehension and reading comprehension (Sears & Keogh, 1993). Replication studies therefore need to include more top-down processes, including a measure of vocabulary and/or listening comprehension.

A strength of this study was its longitudinal design, and use of growth modeling methodology in achieving the study aims. As noted, a key consideration in utilizing this technology is to ensure the judicious selection or adaptation of suitable measurement instruments that yield interval or ratio scaled scores. Researchers are encouraged to incorporate this vital consideration into the planning and designing of longitudinal projects for the study of reading skills in ESL and L1 learners.

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CHAPTER 3. CONCLUSIONS AND RECOMMENDATIONS

This study makes a significant contribution not only to the ESL field, but to the wider reading field as well. This is the first study to map the individual trajectories of reading comprehension in L1 and ESL learners over a critical period of growth and development of reading comprehension skills in the elementary school years. Up to this point, efforts at investigating reading trajectories at the individual level have been limited to the study of basic word reading skills in L1 learners. This research helps define the critical features of the growth trajectories of reading comprehension in ESL and L1 learners. The growth trajectories of these two groups of learners on each of these features were compared. The design of the study made it possible for us to investigate two important questions in the field of ESL research – (i) how similar are ESL learners to L1 learners in their developmental processes (of reading comprehension)? and (ii) do L1 models (of reading comprehension) apply to ESL learners?

Through the use of latent growth modeling, we found high levels of correspondence in the reading comprehension growth trajectories of ESL and L1 learners, namely, in the form or shape of the growth curves, rate of growth or slope of the growth curves, intra-individual variability of the growth curves, and linguistic determinants of the growth curves. Growth in reading comprehension was linear for both groups, and supported by the same basic linguistic processes (word reading, reading fluency, and syntactic awareness). Given the same learning environment, ESL and L1 learners respond to instruction in the same ways, by making the same annual gains in reading comprehension.

Previous research has concentrated on the word level, for which the ESL research base is considerably more substantial. The emerging conceptual viewpoint is that ESL learners are very similar to L1 learners not only in the development of their word reading skills, as has been found, but also in their text comprehension skills. This similarity extends not only to the nature and growth rates of their reading comprehension trajectories, but to the basic linguistic processes that contribute to reading comprehension skill development.

The finding of a marginal lag in the reading comprehension skill levels of ESL learners even as they make commensurate growth in reading comprehension over time places a caveat on the full applicability of L1 models for this special population. The visual representation of growth in reading comprehension in ESL and L1 learners is that of two parallel ascending lines rather than a common single line. We hypothesized that ESL learners may possess specific deficits in the basic underlying processes of reading comprehension that impede their skill attainment in reading comprehension. The study found that such deficits did exist but only in one of the significant predictors of reading comprehension, namely, syntactic awareness. As ESL learners showed no deficits in reading accuracy and reading fluency, a further hypothesis could be that these deficits are localized in the more linguistically demanding 'top-down', rather than 'bottom-up', processes underlying reading comprehension. Further research is necessary to identify the basic processes that have the greatest impact on reading comprehension for ESL learners, and the causal relationships between deficits in these skills and reading comprehension performance for ESL learners.

The question of how closely matched the reading trajectories of ESL learners are to L1 learners is an important empirical question for researchers to pursue. It is only through a rigorous process of teasing apart the similarities and differences that exist between the groups that researchers can begin to retain or modify existing reading models to better explain the developmental processes of reading in ESL learners. It is only through such a systematic process that the field can begin to develop empirically valid explanatory models of reading for ESL learners. With clearer expectations of how the reading skills of ESL learners develop in reference to L1 learners, educators will be better able to assess and evaluate the reading performances of their ESL learners. More importantly, educators will also have greater confidence in knowing what reading and language skills to boost in their ESL students that would lead to positive growth in their reading skills.

In this study, all participants were exposed to a rich literacy learning environment that was driven at the school district level. All participants also had equal opportunity to receive intensive intervention to develop their phonological skills during their initial school years. What the results of this study imply educationally is that given a high quality core reading program, educators can expect ESL learners to make the same rate of growth in their reading comprehension skills as their L1 peers, but at a lower skill level. A possible rationalization for this discrepancy within the current context is that while the early intervention efforts have helped ensure that ESL learners are doing as well as their L1 peers in word reading skills by fourth grade, this has not translated to equal successes in their text comprehension skills. What the results possibly highlight is the need for additional early and appropriate interventions targeted at helping ESL learners make the

transition from word reading to reading for meaning, as successfully as their L1 peers. One possible bridging approach is to enhance instructional and remedial supports for ESL learners in those critical "top-down" underlying processes of reading comprehension, including knowledge of the grammatical and structural aspects of the English language, listening comprehension skills, and oral language proficiency.

It is critical that replication and extension studies be conducted to validate the emergent theoretical conceptualizations arising from this research. Important elements to preserve in future studies are the use of LGM methodology, so as to study growth robustly at the individual level, and the incorporation of L1 reference groups, so as to be able to draw meaningful conclusions about reading development in ESL learners. It was practical, in terms of ensuring a sufficient sample size, to group all ESL students under a single 'ESL' category in the current study. Doing so, however, inadvertently masks the rich diversity and heterogeneity that characterize this unique population of students. It is possible that different language groups, with different language structures and orthographies, could manifest different reading comprehension pathways. It is also possible that the trajectories of reading comprehension within the same language group could be differentiated by such factors as the extent of English spoken in the home. In investigating the reading trajectories of ESL learners, researchers should therefore factor in not just language groups, but other factors that could meaningfully differentiate the skills and abilities of ESL students, such as differences in native language structure and orthography, competency levels of mother tongue or first languages, extent of English spoken outside the school, level of acculturation, etc.

A major strength of this study was its longitudinal design, in particular, the use of latent growth modeling methodology in achieving the study aims. LGM has allowed us to robustly model growth in reading comprehension at the individual and intra-individual levels, and through its unique procedure of multiple group LGM, to directly compare the growth trajectories of the two groups on a wide range of growth dimensions. As shown by this study, LGM can open innumerable possibilities for longitudinal analyses and growth studies that traditional methods cannot achieve. This methodology should be used extensively in longitudinal studies of reading development in both ESL and L1 learners. Researchers need not be restricted to merely studying the effects of single time point predictors on the development of reading comprehension, as was the case in the present study. Instead, studies could be designed to investigate the effects of the growth trajectories of predictors on the growth trajectories of reading comprehension, in other words, how growth in the basic processes influence growth in reading. As noted, a key consideration in utilizing this technology is to ensure the judicious selection or adaptation of suitable measurement instruments that yield interval or ratio scaled scores. This criterion was met in this study through the availability of interval scaled scores in the measure for reading comprehension used, the Stanford Diagnostic Reading Test. Researchers are encouraged to incorporate this vital consideration into the planning and designing of longitudinal projects for the study of reading skills in ESL and L1 learners.

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Appendix I

Oral cloze – Grade 4

Instructions

This time I will read something to you and there will be one word missing. Where the word is missing, I will say ‘‘beep’’. I want you to think of a word that would sound right in the spot where I say ‘‘beep’’. For example, I might say, ‘‘The moon shines bright in the ‘‘beep.’’ (pause and repeat) and I want you to say ‘‘sky’’. OK. Let’s try another one. I’ll say, ‘‘The children ‘‘beep’’ with the toys’’. (pause and repeat). What is 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 puppy wags its ‘‘beep’’. (pause and repeat). Good! Let’s try some more. Note – if the child gives a response greater than one word, ask for a one-word response. Discontinue if the child fails the practice items and the first three task items.

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