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Growth and predictors of change in English language learners' reading comprehension

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This study modelled reading comprehension trajectories in Grades 4 to 6 English language learners (ELLs = 400), with different home language backgrounds, and in English monolinguals (EL1s = 153), and examined an augmented Simple View of Reading model. The contribution of Grade 1 (early) and Grade 4 (late) cognitive, language and word-level reading to Grade 6 reading comprehension was examined. The reading comprehension trajectory was non-linear in ELLs but linear in EL1s. Syntax predicted consistently rate of growth in reading comprehension. ELLs consistently underperformed EL1s on reading comprehension. Word-level reading and all components of language (vocabulary, syntax and listening comprehension) remained stable predictors of Grade 6 reading comprehension. Grade 1 phonological awareness, naming speed and working memory predicted reading comprehension in Grade 6, as did Grade 4 phonological short-term memory. Results support an augmented Simple View of Reading that includes cognitive, word-level and language components, and underscore the importance of considering developmental changes in the constructs.

Introduction

Growth and predictors of change in ELL reading comprehension

Two complementary perspectives form the backbone of this study of reading comprehension in English language learners (ELLs) and monolingual English-speaking (EL1) students – a long-term developmental perspective and a modelling perspective. Although a range of studies show that reading comprehension is an area of weakness for L2 learners, not much is known about long-term developmental growth patterns in reading comprehension of ELLs or in EL1s in upper elementary grades. Moreover, it is not clear whether growth patterns associated with reading comprehension are similar in ELLs and EL1s. A model of reading development that has received much attention is the Simple View of Reading (SVR) (Gough & Tunmer, 1986; Hoover & Gough, 1990). According to the SVR model, clusters of variables associated with language comprehension and those associated with word-level reading skills are the two main interacting 'pillars' underlying reading comprehension. In this paper, we modelled the growth parameters, intercept and slope (i.e., outcome and rate of growth) of reading comprehension in ELLs and EL1s within an augmented SVR framework. The proposed augmented SVR model includes components of oral language comprehension, word-level reading and cognitive processes as predictors of reading comprehension outcome and as predictors of the rate of growth in reading comprehension.

An augmented SVR model

Support for the SVR model comes from studies of monolingual children (e.g., Cain, Oakhill & Bryant, 2004; Joshi & Aaron, 2000; Kendeou, Savage & van den Broek, 2009a; Parrila, Kirby & McQuarrie, 2004). Although L2-based studies converge in documenting that L2 reading comprehension is an area of weakness for L2 learners in comparison with their monolingual peers, they confirm that the SVR model is also supported with L2 learners (e.g., Carlisle, Beeman, Davis & Spharim, 1999; Geva & Farnia, 2012; Hutchinson, Whiteley, Smith & Connors, 2003; Nakamoto, Lindsey & Manis, 2007; Pasquarella, Gottardo & Grant, 2012; Verhoeven & van Leeuwe, 2012). Regardless of the research methodology used (cross-sectional, auto-regressive models or multiple measurement point growth analysis), the studies conducted to date point to the merit of an SVR model augmented with cognitive processes. Of relevance to this paper is an examination of the augmented SVR model in longitudinal studies. Longitudinal studies based on monolinguals provide support for an augmented SVR model (e.g., Johnston & Kirby, 2006; Kendeou, van den Broek, White & Lynch, 2009b; Kirby, Parrila & Pfeiffer, 2003; Oakhill & Cain, 2012; Tilstra, McMaster, van den Broek, Kendeou & Rapp, 2009) as do longitudinal studies of L2 learners (e.g., Gottardo & Mueller, 2009; Lesaux, Rupp & Siegel, 2007; Nakamoto, Lindsey & Manis, 2008; Van Gelderen, Schoonen, Stoel, De Glopper & Hulstijn, 2007; Verhoeven & van Leeuwe, 2012; Yaghoub Zadeh, Farnia & Geva, 2012). In general, the SVR model is augmented by the inclusion of cognitive skills such as naming speed, working memory and meta-cognitive strategies. These cognitive processes make significant contributions to reading comprehension over and above word-level reading and language comprehension, the two pillars of SVR.

At the same time, it is important to emphasise that developmental research has shown that the nature of the predictors and of reading comprehension changes over time and, therefore, that what predicts reading comprehension is not static. Specifically, longitudinal studies involving monolingual children have shown that performance in the early school years on word-level reading skills predicts a substantial amount of variance in later reading comprehension. However, in subsequent years, as word-level reading skills become established, language skills become stronger and more reliable predictors of reading comprehension (e.g., Catts, Fey, Zhang & Tomblin, 1999; Cutting & Scarborough, 2006; Francis et al., 2005; Storch & Whitehurst, 2002). This general observation is supported in L2-based studies as well (Geva & Farnia, 2012; Verhoeven & van Leeuwe, 2012).

Although there is overwhelming evidence indicating that language comprehension plays a crucial role in reading comprehension, it is not clear whether the components of language comprehension (e.g., vocabulary breadth and depth, syntax, morphology and listening comprehension) should be treated as interchangeable proxies of a general construct of language comprehension. An auto-regressive study of young English monolingual children has shown that, when entered in the model simultaneously, listening comprehension and vocabulary measured in kindergarten were unique predictors of reading comprehension 2 years later (Kendeou et al., 2009b). It is not clear, however, whether the components of language comprehension uniquely predict reading comprehension of older ELL and EL1 learners and whether the role of language comprehension increases in reading comprehension of upper elementary ELL and EL1 students.

A recent auto-regressive study that examined early (Grade 2) and late (Grade 5) predictors of reading comprehension in Grade 5 ELLs and EL1s provided support for the notion that depending on the time of assessment, different aspects of language comprehension emerge as critical to reading comprehension (Geva & Farnia, 2012). The authors suggest that from the outset, there are individual differences in the rate of L2 learning that may predict subsequent reading comprehension. Moreover, because language comprehension is complex and multidimensional, what constitutes language comprehension changes over time; therefore, different aspects of language comprehension predict reading comprehension.

The present study focused on developmental trajectories of reading comprehension in upper elementary ELLs and EL1s. It examined longitudinally the adequacy of an SVR model, augmented with cognitive processing skills, and three different aspects of language comprehension – vocabulary, syntax and listening comprehension.

Growth trajectories of reading comprehension in L2 and L1

There is general agreement that when skills are examined over a long time, their growth can rarely be characterised as linear (Singer & Willett, 2003). Acceleration or deceleration in reading comprehension may occur as a function of general developmental processes, individual differences in underlying cognitive-linguistic mechanisms, contextual influences involving exposure, instruction and socioeconomic status, and characteristics of the measures used.

A number of studies examined reading comprehension development between two time points. These studies, based on auto-regressive models, provide useful information about predictors of reading in monolinguals (e.g., Kendeou et al., 2009b; Kirby et al., 2003; Oakhill & Cain, 2012; Parrila et al., 2004) and L2 learners (e.g., Lesaux et al., 2007; Van Gelderen et al., 2007). However, auto-regressive studies cannot provide information on patterns of change in reading comprehension over multiple time points.

Currently, there is a dearth of longitudinal studies that have modelled growth in reading comprehension over more than two time points. Studies such as those of Speece, Ritchey, Cooper, Roth and Schatschneider (2004) and Lervåg and Aukrust (2010) focused on the development of reading comprehension in the primary grades. Speece et al. (2004) examined growth from Grade 1 to Grade 3 in English monolinguals. They assumed a linear trajectory, arguing that it would not be possible to test for a non-linear effect with three measurement points (but see Duncan and Duncan, 2004).

Lervåg and Aukrust (2010) modelled the reading comprehension of second-grade monolingual Norwegian children and of children with Urdu as their L1 and Norwegian as their L2. They used briefer intervals than the previous researchers, assessing reading comprehension on four occasions over 18 months, with two comprehension measures. They found a non-linear growth pattern on the Norwegian translation of the passage comprehension subscale of the Woodcock Reading Mastery Test, in both language groups. However, on the Neale Analysis of Reading Ability Test, different patterns emerged in the Norwegian monolinguals and Urdu groups. The growth trajectory of reading comprehension in Norwegian for Urdu as L1 was non-linear, whereas it was linear for the Norwegian monolinguals. The lack of consistency in findings pertaining to developmental patterns in reading comprehension may reflect the nature of what different reading comprehension tests measure (Keenan, Betjemann & Olson, 2008; Grant, Gottardo & Geva, 2012) as well as differences in the intensity of intervals between measurements.

To the best of our knowledge, only two studies examined patterns of growth in reading comprehension in English monolinguals through upper elementary school (Catts, Bridges, Little & Tomblin, 2008; Parrila, Aunola, Leskinen, Nurmi & Kirby, 2005), and two published studies modelled patterns of growth in reading comprehension of upper elementary ELLs (Mancilla-Martinez, Kieffer, Biancarosa, Christodoulou & Snow, 2011; Nakamoto et al., 2007). Catts et al. (2008) modelled reading comprehension trajectories of typically developing and language-impaired monolingual English-speaking students assessed at four time points – Grades 2, 4, 8 and 10. They reported that both groups showed non-linear patterns, with initial acceleration in reading comprehension from Grades 2 to 4, followed by deceleration between Grades 4 and 8. Parrila et al. (2005) studied the development of reading comprehension of English-speaking students from Grade 1 to Grade 6. Parrila et al. (2005) used growth mixture modelling and fitted a latent growth quadratic model for reading comprehension and reported that overall reading comprehension trajectories followed a non-linear trend. In addition, they reported that the reading comprehension gap between children with lower baseline performance and children with higher baseline performance gradually narrowed over time.

As reported in studies based on monolingual learners, Nakamoto et al. (2007), who tracked ELLs from Grade 1 to Grade 6, also found that reading comprehension trajectories of ELLs with Spanish as L1 can be characterised as non-linear. Finally, Mancilla-Martinez et al. (2011) modelled growth in reading comprehension at four time points between Grades 5 and 7 in Spanish-speaking ELLs. They also found a non-linear growth pattern with a gradual deceleration to Grade 7.

One explanation for this often reported non-linear developmental pattern of reading comprehension, characterised by initial steep development in the lower grades, followed by deceleration in subsequent years, is that it is tied to the changing nature of the skills necessary to comprehend texts. The change in the patterns of reading comprehension growth may reflect a shift in the nature of the reading comprehension construct itself, from heavy reliance on word recognition skills to a highly complex task that demands the integration of language skills, background knowledge, strategic knowledge and working memory. Relatedly, Gottardo and Mueller (2009) have shown that in the early school years, although oral language skills play some role in reading comprehension, the comprehension of texts relies extensively on word-level reading skills. However, language skills become more prominent in reading comprehension when the basic principles of word-level reading have been more or less established and the texts students read present more demanding language skills (e.g., Geva & Farnia, 2012; Whitehurst & Lonigan, 2002).

It is not unlikely that the initial steeper growth reported by Catts et al. (2008) and Nakamoto et al. (2007) reflects growth in word-level reading skills and that the deceleration in later years is concomitant with an increase in language-processing and cognitive demands on reading comprehension tests (Muter, Hulme, Snowling & Stevenson, 2004; Tabors, Snow & Dickinson, 2001). To examine this hypothesis, we modelled the developmental trajectories associated with reading comprehension and examined early (Grade 1) and late (Grade 4) predictors of growth parameters in reading comprehension of ELLs and EL1s in upper elementary grades.

The present study

In this study, we modelled the growth of reading comprehension in ELLs and EL1s and examined an augmented SVR model that considers the contributions of cognitive processes, oral language comprehension and word-level reading not only to outcome but also to rate growth in reading comprehension. The objectives of the study were to (a) compare the rate of growth in reading comprehension in ELL and EL1 students from Grade 4 to Grade 6 and determine whether growth is linear or non-linear in each of the groups; (b) examine the adequacy of an SVR model augmented with cognitive-processing skills in predicting reading comprehension growth parameters (rate of growth and outcome). Within this framework, we examined whether 'early' (Grade 1) and 'late' (Grade 4) predictors of reading comprehension play a differential role in predicting reading comprehension rate of growth and Grade 6 outcome. In addition, within these early and late augmented SVR models, we examined the potential unique contribution of different components of oral language (i.e., vocabulary, syntax and listening comprehension) to reading comprehension growth and outcome.

We used growth-curve modelling (i.e., Hierarchical Linear Modelling; Raudenbush & Bryk, 2002) to study patterns of growth over 3 years in the reading comprehension of ELLs and EL1s. Regardless of whether growth is linear or non-linear, it is possible to entertain various scenarios for the development of reading comprehension in ELLs and EL1s. For example, theoretically, with the cumulative effects of language exposure and instruction, growth may be steeper in the ELLs than in the EL1s and the monolingual advantage may dissipate over time, resulting in a narrowing of the gap. On the basis of prior research on reading comprehension in ELLs and EL1s, another scenario is that ELLs will continue to have lower reading comprehension than their monolingual peers and that the gap between ELLs and EL1s will remain constant. In the third scenario, the gap in reading comprehension may increase over time. We explored the data to find out what scenario fits the data and then examined the role of the predictors in explaining the growth patterns that were identified.

Method

Participants

Demographic background. The data used are part of a longitudinal study that involved 12 schools in four boards of education in a large multiethnic and multilingual metropolis in Ontario, Canada. The study was launched in 1996 and involved 614 participants. It included four successive cohorts of Grade 1 students who were each followed for 6 years. We asked the schools to identify children with known conditions such as dyslexia, speech or language impairment, hearing problems, autism spectrum disorder or acquired brain injuries, and they were excluded at the screening stage. The data of students who spoke nonstandard English ($n = 27$), students with nonverbal ability scores equal to or less than 80 ($n = \text{ELL} = 7$; n EL1 = 5) or ELLs who had had more than 2 years of schooling/daycare in English ($n = 20$) prior to Grade 1 were excluded from the analyses.

The final sample included 553 ELL and EL1 students. The ELL sample consisted of 400 students whose home languages were Punjabi ($n = 133$), Gujarati ($n = 55$), Tamil ($n = 51$), Cantonese ($n = 50$), Portuguese ($n = 92$) or other languages ($n = 19$). The EL1 sample included 153 monolingual English-speaking students. At initial testing (Grade 1), the mean age of the ELL group was 6 years and 4 months ($SD = 6.67$ months), and the mean age of the EL1 group was 6 years and 5 months ($SD = 6.5$ months). There were 203 girls and 197 boys in the ELL, and 92 girls and 61 boys in the EL1 groups. The majority of students lived in large urban areas designated by Statistics Canada (2004) as having low income/socioeconomic status neighbourhoods. It is important to note that the ELL and EL1 students came from the same schools and were drawn from the same classes. Eighty-one per cent of the ELLs ($n = 244$) for whom data on the country of birth are available were born in Canada, but spoke a language other than English at home.

ESL instruction. In Ontario, children who have recently emigrated from non-English-speaking countries or have limited English proficiency upon school entry are designated as English as a second language (ESL) students and placed in regular classrooms. Initially, ESL services are provided daily for 30–40 minutes, on a withdrawal basis. English language instruction is provided by trained ESL teachers for up to 2 years. For the remainder of the day, students receive instruction in the regular classroom in English, together with their EL1 peers. The ESL classes typically comprise students of various ages and home language backgrounds, and children are grouped by level of English language proficiency. In the regular classroom, teachers make appropriate adaptations and accommodations to the programming and curriculum for their ELL students. At the onset of the study, 146 participants in the ELL group were enrolled in these ESL classes.

Procedures

The measures were part of large batteries of tests that were administered in the fall and spring of Grades 1 and 2, and in the middle of each successive school year (Grade 3 to Grade 6). Students were tested individually in a quiet room in their schools during five 30- to 35-minute sessions. The assessments were conducted by graduate students or research assistants who completed a 2-day rigorous training programme in test administration and reached a high level of proficiency. All protocols were checked by a second tester to verify the completeness of the information. See Appendix A for an overview of the cognitive, language and reading skills assessed at each measurement point. Depending on the tasks, the participants were tested individually or in small groups. ELL students had sufficient knowledge of the English language to understand the task instructions, which were given in English.

Measures[1]

We used data collected in Grades 4, 5 and 6 to model growth in reading comprehension. Cognitive, language and word-level reading skills assessed in Grade 1, the baseline data, and reading comprehension assessed in Grade 2, the auto-regressor, were treated as early predictors of growth (slope) in reading comprehension and of the final (Grade 6) outcome. In addition, cognitive, language and word-level reading skills assessed in Grade 4 were treated as later predictors of growth in reading comprehension and of the final outcome

(Grade 6). Reading comprehension was not assessed in Grade 1 because the participants were beginning readers with emerging decoding skills.

Nonverbal ability. The Matrix Analogy Test (MAT; Naglieri, 1985) is a standardised measure that was used to assess individual differences in nonverbal ability. In each item, children are asked to point to an abstract shape that completes a pattern. The test requires minimal verbal comprehension and no verbal response on the part of the examinee. There is research evidence that the MAT can be administered to minority children with limited proficiency in English and that it is a valid measure of their cognitive ability (Naglieri & Ronning, 2000). Naglieri (1985) reports an internal consistency of .83. The MAT was administered in the spring of Grade 1, and standard scores were analysed. Consistent with traditional criteria, only the data from students with standard scores of 80 or higher were included.

Working memory. The backward digit span subtest of the Wechsler Intelligence Scale for Children, Third Edition (WISC-III; Wechsler, 1991), was used to measure individual differences in working memory. The task assesses intake, maintenance, processing and retrieval of information. Children are required to recall, in reverse order, a series of orally presented digits that increase in set size. Administration is interrupted when both sets in the same trial are wrong. According to the NLSY report, digit backward is more culturally neutral than digit forward (Baker, Keck, Mott & Quinlan, 1993). The test developers report an internal consistency reliability of .80. In this study, the test–retest reliability of this task was .69 and .67 for ELL and EL1 students, respectively.

Phonological processing.[2] Three aspects of phonological processing were assessed: phonological short-term memory, phonological awareness and naming speed.

Phonological short-term memory. The Test of Nonword Repetition (Wade-Woolley, 1999) consists of 25 of the 50 items on the original task developed by Gathercole, Willis, Baddeley and Emslie (1994), modified to avoid unfamiliar phonemes or syllable structure. The number of syllables increases gradually, with 10 2-syllable, 5 3-syllable, 5 4-syllable and 5 5-syllable English nonwords (e.g., gotty, commeecitate). The task was professionally recorded, using a female voice. Participants listened to the tape-recorded items presented one at a time and were instructed to repeat each nonword as accurately as possible. Each item was preceded by a bell. There was no stop-rule procedure for this task. Students' responses were recorded and scored later. Each correctly repeated item received a score of 1. The Cronbach's α (internal consistency) was. 75 for ELLs and .73 for EL1s.

Phonological awareness. An adapted version of the Auditory Analysis Test (Rosner & Simon, 1971) was used to measure phonological awareness. To minimise the effect of lexical knowledge and an EL1 advantage, only high-frequency words were used for the initial stimuli and target responses in this task (e.g., sunshine, picnic and leg). The task consists of 25 items comprising three sets of progressive difficulty. In the first set, the students were asked to delete one syllable in either the initial or final position of a spoken word (e.g. 'Say "sunshine"'; 'Say it again but don't say "shine"'). The second set required deletion of initial or final single phonemes in one-syllable words (e.g., 'Say "hand"'; 'Say it again but don't say the '/h/'). The third subtest involved deletion of single phonemes in an initial or final consonant blend in a word (e.g., 'Say "stop"'; Say it again without "/s/"'). The internal consistency for this test was .92 and .89 for ELL and EL1, respectively.

Naming speed. The letter-naming section of Denckla and Rudel's (1976) Rapid Automatization Naming Test (RAN) was used. It includes five letters, each appearing 10 times in a random order. Accuracy and time (in seconds) to name all 50 items were recorded. The speed of naming was calculated as the number of correct letters per second.

Word-level reading. Two components of word-level reading skills were assessed: real-world reading and pseudoword decoding.

Real-world reading. The word reading subtest of Wide Range Achievement Test-Revised (Wilkinson, 1993) was administered to assess students' ability to read isolated words in English. This test consists of 42 monosyllabic and polysyllabic words. The word items involve nouns, verbs, adjectives and prepositions. The test is discontinued after 10 consecutive errors. The total number of correctly read words made up the score and was recorded for each student. The internal consistency for this test was .92 and .96 for ELL and EL1, respectively.

Pseudoword reading. The Word Attack subtest of the Woodcock Reading Mastery Test–Revised (Woodcock, 1987) was administered to assess students' ability to apply grapheme–phoneme correspondence rules in decoding pseudowords. The test consists of 45 'nonwords' that conform with the rules of English orthography (e.g., 'bufty', 'mancingful'). The total number of correctly read items made up the score and was recorded for each student. The internal consistency for this test was .87 and .95 for ELL and EL1, respectively.

Reading comprehension: a Grade 2 auto-regressor. An experimental reading comprehension measure that was administered to the children in Grade 2 was treated as an auto-regressor. An experimental reading comprehension measure was administered as there was reluctance to allow the administration of standard tests to ELLs in the early grades. This measure was adapted from the Durrell Analysis of Reading Difficulty (Durrell, 1970). Children read aloud three short stories varying in difficulty. There were seven idea units in each story and five open-ended questions (four of a factual nature and one inferential) that were presented to them orally. After reading each story, children retold the story and answered the five questions. Children's responses were recorded and analysed later by two trained raters. One point was given for each idea unit recalled and one point for each correct answer. Each story had a maximum score of 12, and the total score was 36. There was an 87% agreement rate between the raters. The internal consistency for this test was .75 and .73 for ELL and EL1, respectively.

Oral language skills. Three components of oral language were assessed: receptive vocabulary, syntax and listening comprehension.

Receptive vocabulary. The Peabody Picture Vocabulary Test–Revised (Dunn & Dunn, 1981) measures receptive vocabulary. Children hear a word, are shown four pictures and are asked to point to the picture that matches the word heard. The internal consistency for this test was .92 and .93 for ELL and EL1, respectively.

Syntax. An adapted and abbreviated version of the Grammaticality Judgment Task (Johnson & Newport, 1989) was used to test participants' English syntactic knowledge. The task consists of 40 sentences: 20 syntactically correct (e.g., 'The man burned the dinner.') and 20 syntactically incorrect (e.g., 'Last night the books falled off the shelves.'). The task tests a wide variety of English syntactic properties such as function words, word order, phrase order, clause boundaries, pronominalisation, tense, markers, articles, subject–predicate agreement and copula words. Only relatively high-frequency words were used, and the sentences were constructed with items whose intended meaning was transparent, to control for semantic knowledge and to reduce possible effects of lexical familiarity on students' performance. Each sentence was played twice on a tape recorder. The students' task was to indicate whether the sentence they heard was said 'the right way' or 'the wrong way'. The score was based on the number of correctly judged sentences. The internal consistency of the task was .77 and .80 for ELLs and EL1s, respectively.

Listening comprehension. An experimental measure of listening comprehension was adapted from the Durrell Analysis of Reading Difficulty (Durrell, 1970). This measure comprises two short stories (about a paragraph in length) that represent different difficulty levels. There are eight idea units, one inferential and four factual multiple-choice questions in each story. Each story was read to the students. They were instructed to listen to the stories carefully as they would be asked to retell the story and answer some questions about it. After listening to each story, students retold it and then answered the comprehension questions, which were presented orally. Each story had a maximum score of 13, and the total score was 26. The stories used in this test were different from those used in the Grade 2 reading comprehension auto-regressor.

Students' story retelling and answers were tape-recorded. The recordings were later transcribed and scored by two native English-speaking raters. For the free-recall component, students were given one point for each idea unit recalled. One point was also given for each correctly answered oral comprehension question. Students were not penalised for making grammatical errors in the free-recall or the question–answer components of this task. The internal consistency of the task was .73 for ELLs and .47 for and EL1s.[3] The inter-rater reliability was greater than 85% on individual items.

Reading comprehension. The GMRT (MacGinitie & MacGinitie, 1992) was used to measure reading comprehension in Grades 4 to 6. The GMRT contains short narrative, information and expository passages, each of which is followed by multiple-choice questions. The test, which has a time limit of 35 minutes, was administered in groups of five. The internal consistency of the task was .85 for ELLs and .90 for EL1s. ESSs were used to examine gains across years of testing. To illustrate, an ESS of 500 indicates an average performance level at the beginning of Grade 5, and an average achievement at the beginning of Grade 6 is equivalent to an ESS of 525. That is, a difference of 25 ESS units anywhere on the scale is the difference between the achievement of beginning Grade 5 and beginning Grade 6 students. These properties make the ESS ideal for measuring growth trajectories in longitudinal studies where different forms are used for different grade levels. For the ELLs, the range of ESSs was 292 to 649, 359 to 669 and 344 to 642 in Grades 4, 5 and 6, respectively. For the EL1s, the range of ESSs was 341 to 628, 404 to 669 and 344 to 679 in Grades 4, 5 and 6, respectively.

Results

This section begins with a brief discussion of methodological considerations, followed by descriptive statistics and inter-correlation matrices. We then present results pertaining to growth in reading comprehension and results pertaining to predictors of growth parameters within an augmented SVR framework.

Methodological considerations

Missing data. Inevitable attrition reduced the sample over 6 years of data collection. School records indicated that mobility was the most common reason associated with data attrition. To avoid biased estimation and loss of sample size, it was important to handle appropriately the 23.5% missing data that resulted from attrition or omissions (see Appendix B for information regarding the percentage of available data across measurement points). We used multiple imputation procedure (Little & Rubin, 2002) to estimate the missing cells and incomplete data points (Schafer & Graham, 2002) and to provide unbiased and efficient parameter estimates.

To justify the use of this method, the data must be 'missing completely at random' or 'missing at random' (Peugh & Enders, 2004). To ensure that the attrition was random, it was necessary to establish first that attrition did not contribute in a systematic way to variability in the outcome variable (i.e., reading comprehension) or in nonverbal ability scores. In addition, we wanted to establish that the rates or patterns of attrition were not different for the ELL and EL1 groups, or for men and women. To accomplish these aims, we conducted a sensitivity analysis (Schulz, Chalmers, Hayes & Altman, 1995). A taxonomy of multi-level models for reading comprehension growth was fitted to examine and control for incomplete sample bias (Table 1). In particular, we examined the effects of attrition on the initial (Grade 4) reading comprehension outcome and rate of growth after the effects of language status (ELL vs EL1), nonverbal ability and gender were accounted for. When 'Dropout' was entered in the model as a single predictor of reading comprehension, no statistically significant differences were found between the reading comprehension outcome of students who dropped out and those who remained in the study, $t(551) = 0.34$, $p = 0.734$. Nor were there any statistically significant interaction effects between dropout rate, language status, gender and nonverbal ability on the reading comprehension outcome of the dropouts versus the participating students, $t(548) = 0.31$, $p = 0.760$.

Subsequently, we multiply imputed ($m = 5$) the missing data points, using Schafer's (2000) NORM programme, which replaces missing data with plausible values. Seventy-two per cent of the 23.5% missing data were replaced by the programme. The five resultant data sets were used in all subsequent analyses (employing multiple imputations options under the estimation setting menu of Hierarchical Linear Modelling.)

ELL and EL1 performance on early and late predictors and on reading comprehension

General linear models were used to evaluate group differences. A summary of descriptive analyses for early (Grade 1) and late (Grade 4) predictor variables and reading comprehension in Grades 4 to 6, as well as F values and effect sizes (partial Eta^2) are presented in Table 2. We compared the performance of ELLs and EL1s on Grade 1 and Grade 4 cognitive, language and word-level reading skills and on Grades 4 to 6 reading comprehension. In analyses

Table 1. Taxonomy of multi-level models for reading comprehension growth to control for incomplete sample bias.

	Model 1	Model 2	Model 3	Model 4	Model 5
Fixed effect					
Reading comprehension 4	474.08***	473.28***	488.30***	478.84***	479.64***
	(2.16)	(3.52)	(4.98)	(5.50)	(5.43)
Dropout		1.46	2.77	3.15	1.32
		(4.46)	(4.24)	(4.37)	(4.32)
ELL			−21.73***	−19.75***	−19.75***
			(4.76)	(4.83)	(4.76)
Gender				15.05**	15.35**
				(4.25)	(4.18)
Nonverbal ability					0.79***
					(0.21)
Rate of growth (linear)	1.94	1.51	1.04*	1.40*	1.37
	(0.54)	(0.27)	(0.50)	(0.47)	(0.50)
Dropout		0.70	0.68	0.70	0.80
		(0.34)	(0.37)	(0.35)	(0.34)
ELL			0.62	0.51	0.49
			(0.44)	(0.41)	(0.41)
Gender				−0.53	−0.58
				(0.33)	(0.34)
Nonverbal ability					−0.03*
					(0.02)
Rate of growth (non-linear)	−0.04	−0.02	−0.00	−0.01	−0.01

(*Continues*)

Table 1. (Continued)

	Model 1	Model 2	Model 3	Model 4	Model 5
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
Dropout		−0.03	−0.03	−0.03	−0.03
		(0.02)	(0.02)	(0.02)	(0.01)
ELL			−0.03	−0.03	−0.03
			(0.02)	(0.01)	(0.02)
Gender				0.02	0.02
				(0.01)	(0.01)
Nonverbal ability					0.002*
					(0.01)
Random effects					
Reading comprehensinon 4	2004.77***	2007.13***	1919.75***	1878.73***	1808.59***
	(44.77)	(44.80)	(43.81)	(44.56)	(42.53)
	Deviance = 16876	Deviance = 16874	Deviance = 16852	Deviance = 16840	Deviance = 16835

ELL, language status variable (ELL vs EL1).
*Significant at the 0.05 level; **Significant at the 0.01; ***Significant at the 0.001.

involving group comparisons, we used a minimal alpha level of 0.01 to reduce the likelihood of type I errors, given the large number of group comparisons. In Grade 1, ELLs performed significantly lower than EL1s on working memory, vocabulary, syntax and listening comprehension but not on the other measures. In Grade 4, ELLs continued to perform more poorly on oral language measures but not on working memory. As for reading comprehension, ELLs had lower scores than EL1s in Grades 4, 5 and 6.

Table 3 presents correlations between predictor variables at school entry (Grade 1) and Grade 6 reading comprehension, the outcome variable. The bulk of the bivariate correlations showed small to moderate, positive and significant associations between the predictors and the outcome variable in both ELL and EL1 groups. The only exception involved naming speed: it was moderately correlated with reading comprehension in the case of the EL1s but only marginally in the case of the ELLs. There were positive and moderate correlations between reading comprehension, and language measures and word-level reading skills.

Table 4 presents correlations between Grade 4 predictor variables and Grade 6 reading comprehension. The bivariate correlations showed small to moderate, positive and significant correlations between the predictors and the outcome variable in both ELL and EL1 groups. Interestingly, the Grade 4 correlation between naming speed and the reading measures was substantial in the ELL group as well and resembled results in the EL1 group. Similar correlations were seen between reading comprehension, and word-level reading and language measures in ELLs and EL1s.

Growth trajectories of reading comprehension in ELLs and EL1s

The first objective of this study was to compare the rate of growth in reading comprehension in ELL and EL1 students from Grade 4 to Grade 6 and to determine whether growth is linear or non-linear in each of the groups. Visual examination of the scatter plots indicated that reading comprehension growth was non-linear. In general, as shown in Table 1, all participants developed reading comprehension skills at a faster rate from Grade 4 to Grade 5 than from Grade 5 to 6. Following the work of Duncan and Duncan (2004), we tested whether the data were fundamentally non-linear. To examine the patterns of growth in reading comprehension, we fitted the unconditional linear growth model – models with time as the only predictor, $t(1657) = 15.59$, $p < .001$, and a model with non-linear terms, $t(1657) = -4.94$, $p < .001$, to the Grade 6 reading comprehension outcome. The chi-square difference test showed that the change in deviance (ΔD) exceeded the critical value of the chi-square and that the difference was statistically significant, $\chi^2(2) = 18.78$, $p < .001$. Test of covariance components for the model fit indicated that, for these data, the use of a non-linear term was supported in explaining variations in reading comprehension trajectories.

Individual early and late predictors of reading comprehension rate of growth and outcome

To model Grade 6 reading comprehension outcome, we centred the outcome around the students' mean age in Grade 6. Results showed considerable variability in students' scores in Grade 6 reading comprehension. The extent to which the early predictor variables contributed to later reading comprehension of ELL and EL1 students was examined first as individual predictors of change. Next, we examined a final combined model that included all the significant predictor variables, as indicated by the initial, exploratory,

Table 2. Descriptive statistics for all variables included in the study for English language learner (ELL) and EL1 students.

	ELL ($n = 400$)					EL1 ($n = 153$)				
	Mean	*SD*	Min	Max	Mean	*SD*	Min	Max	*F*(552)	*Eta*^{2}
Nonverbal ability	101.13	10.40	81	140	100.92	8.65	81	129	−.05	−.00
Grade 1 (early) predictors										
Working memory	2.38	1.22	0	12	2.71	1.04	0.0	6	8.86*	.02
Phonological memory	15.84	1.02	5	24	16.55	3.23	9	24	3.79*	.01
Phonological awareness	7.14	4.31	0.0	24	7.75	3.27	0.0	17	2.47	.01
Naming speed	1.24	.53	0.21	5	1.22	0.55	0.35	5	.02	−.00
Vocabulary	48.77	17.18	5	100	64.43	14.73	33	100	99.20**	.15
Syntax	20.41	4.84	8	35	22.50	5.15	11	33	19.87**	.04
Listening comprehension	11.31	5.68	0.0	26	14.51	4.38	2	25	39.56**	.08
Pseudoword decoding	5.45	6.64	0.0	38	5.92	6.10	0.0	33	.59	.00
Word recognition	18.87	4.90	0.0	33	18.97	4.48	4	34	.06	.00
Grade 2 auto-regressor										
Reading comprehension	19.01	8.73	0.0	36	20.46	8.27	0.0	36	3.15	.01
Grade 4 (late) predictors										
Working memory	4.65	1.78	0.0	12	4.44	1.51	0.0	8	1.52	−.01
Phonological memory	18.85	3.13	7	25	19.32	2.97	10	25	2.59	.01
Phonological awareness	16.85	4.55	6	28	15.84	3.97	6	25	5.90*	−.01
Naming speed	2.10	.55	0.79	4.55	2.02	0.43	1.17	3.33	2.55	−.01
Vocabulary	94.58	16.34	21	153	107.78	13.09	71	144	80.19**	.13
Syntax	30.07	5.15	15	40	31.53	5.41	18	40	8.84**	.03
Listening comprehension	13.51	4.14	2	25	15.85	3.71	5	25	37.16**	.06
Pseudoword decoding	26.91	9.46	0.0	43	27.10	8.75	2	43	0.05	.00

Word recognition	33.87	5.81	19	50	33.98	5.14	20	42	0.04	.00
Reading outcome[a]										
Reading comprehension 4	465.16	50.07	292	649	487.82	50.92	341	628	22.45**	.04
Reading comprehension 5	486.90	50.23	359	669	510.89	51.19	404	669	24.98**	.04
Reading comprehension 6	489.20	53.64	344	642	519.95	55.95	344	679	35.43**	.06

[a]Numbers 4, 5 and 6 refer to the respective grade levels.
*Significant at the 0.01 level; **Significant at the 0.001.

Table 3. Correlations among Grade 1 cognitive, language and word-level reading measures, and Grade 6 reading comprehension in English language learners (ELLs; bottom diagonal) and EL1s (top diagonal).

	1	2	3	4	5	6	7	8	9	10	11	12
1. Nonverbal ability	–	.08	.14	.18*	.06	.26**	.09	.18*	.11	.08	.17*	.18*
2. Working memory	.28**	–	.30**	.45**	.12	.45**	.30**	.40**	.35**	.31**	.35**	.47**
3. Phonological memory	.28**	.33**	–	.32**	.17*	.31**	.27**	.35**	.25**	.39**	.39**	.39**
4. Phonological awareness	.29**	.42**	.37**	–	.41**	.22**	.32**	.31**	.51**	.51**	.45**	.47**
5. Naming speed	.10*	−.03	.02	.11*	–	.08	.01	.02	.43**	.57**	.36**	.25**
6. Vocabulary	.38**	.47**	.33**	.49**	.15**	–	.49**	.55**	.16	.26**	.47**	.50**
7. Syntax	.13*	.21**	.14**	.42**	.07	.37**	–	.26**	.26**	.22**	.35**	.54**
8. Listening comprehension	.33**	.33**	.39**	.39**	.13**	.58**	.26**	–	.07	.17*	.39**	.37**
9. Pseudoword decoding	.25**	.35**	.39**	.62**	.08	.36**	.28**	.31**	–	.72**	.30**	.32**
10. Word recognition	.31**	.40**	.50**	.53**	.16**	.39**	.18**	.43**	.68**	–	.56**	.42**
11. Reading comprehension 2[a]	.22**	.40**	.35**	.45**	.49**	.46**	.24**	.50**	.41**	.68**	–	.55**
12. Reading comprehension 6[a]	.21**	.35**	.30**	.48**	.13**	.46**	.41**	.41**	.26**	.43**	.59**	–

[a]Numbers 2 and 6 refer to the respective grade levels.
*Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed).

analyses. Similar procedures were followed to examine the Grade 4 predictors of growth and reading comprehension outcome.

Utilising a simple conditional model– models with one person-level variable as a predictor, we first entered the language status variable 'ELL' with a value of '1' for ELLs and a value of '0' for EL1s, to examine group differences in rate of growth and reading comprehension outcome. ELLs performed significantly more poorly than EL1s on Grade 6 reading comprehension, $t(551) = -4.92$, $p < .001$, and there was a significant levelling off in the rate of growth of reading comprehension for ELLs, $t(1653) = -2.08$, $p = .02$, whereas for the EL1 group, it was linear (Figure 1[4] and Table 2).

In the simple conditional models, all the individual predictor variables included in the augmented SVR model were significant predictors of Grade 6 reading comprehension of ELL and EL1, whether assessed in Grade 1 or Grade 4. As for the individual predictors of reading comprehension rate of growth, whether measured in Grade 1 or in Grade 4, vocabulary and syntax were significant. It is important to note that vocabulary was a negative predictor of the rate of growth, whereas syntax was a positive predictor of rate of growth in reading comprehension. Different Grade 1 and Grade 4 individual cognitive variables predicted rate of growth in reading comprehension: in Grade 1, naming speed was a significant predictor, whereas in Grade 4, phonological short-term memory was significant. In what follows, we focus on describing and interpreting the combined final models in which all the individual significant predictors of Grade 6 reading comprehension and of the rate of growth in reading comprehension from Grade 4 to Grade 6 are considered jointly.

Early and late predictors of reading comprehension rate of growth and outcome in an augmented SVR framework: final combined models

The second objective of this research involved examining the adequacy of an SVR model augmented with cognitive variables in predicting reading comprehension rate of growth and outcome. Two fitted combined models were examined, one with all significant Grade 1 individual cognitive, language, word-level reading and Grade 2 reading comprehension

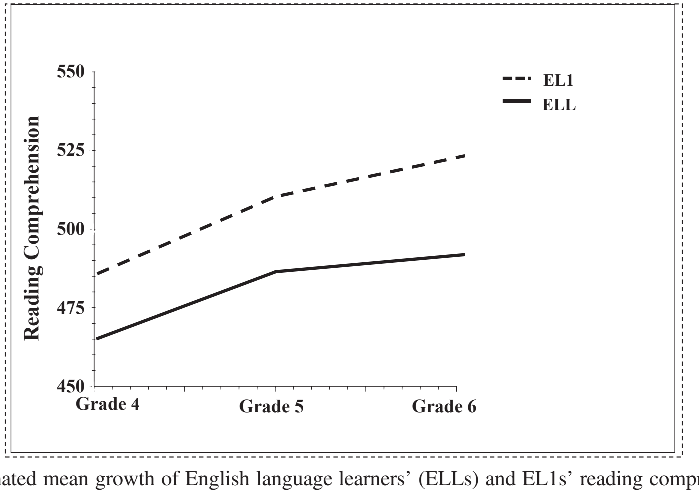

Figure 1. Estimated mean growth of English language learners' (ELLs) and EL1s' reading comprehension.

predictors, and one with all significant Grade 4 individual cognitive, language and word-level reading predictors. To examine whether different components of oral language contribute uniquely to reading comprehension, we entered vocabulary, syntax and listening comprehension in the final combined models. The results of the final combined models are presented in the left and right panels of Table 5 for the Grade 1 and Grade 4 predictors, respectively.

Combined early predictors of the rate of growth and of outcome. Considering the results of previous analyses, the ELL variable and the significant Grade 1 cognitive, language, word-level reading variables, reading comprehension auto-regressor and vocabulary by syntax interaction were entered jointly into the growth models as early predictors of reading comprehension outcome. Also, the ELL variable, nonverbal ability, naming speed, vocabulary and syntax were entered as predictors of growth in reading comprehension. Results of the combined models with ELL and Grade 1 predictors indicated that when entered simultaneously into the model, working memory, phonological awareness, phonological short-term memory, syntax, listening comprehension and reading comprehension made significant independent contributions to individual differences in reading comprehension outcome. However, only Grade 1 syntax retained its significant contribution to the rate of growth in reading comprehension. The Grade 1 vocabulary by syntax interaction did not contribute to the final outcome or to the rate of growth in reading comprehension. Results indicated that 64% of the variance in the Grade 6 reading comprehension outcome was explained by the model.[5]

These results indicated that the ELL variable did not explain any variance in the growth parameters of reading comprehension. Moreover, regardless of language status, on average, students with better performance on any of the cognitive and oral language skills measured in Grade 1 attained relatively high levels of reading comprehension outcome compared with those whose performance on the predictors was lower. Also, word recognition assessed in Grade 1 had significant association with reading comprehension outcome. Grade 1 syntax was a significant predictor of the reading comprehension rate of growth in both language groups, and it was positively associated with development. That is, better performance on Grade 1 syntax was associated with more rapid development in reading comprehension from Grade 4 to Grade 6, and poorer performance was associated with a slower rate of growth (Figure 2).

Combined late predictors of the rate of growth and of outcome. The ELL variable and the significant Grade 4 cognitive variables, aspects of oral language and word-level reading variables as well as the vocabulary by syntax interaction term were entered jointly into the combined model as late predictors of reading comprehension outcome. Also, Grade 4 phonological short-term memory, vocabulary, syntax and the interaction term of vocabulary and syntax were entered as predictors of rate of growth in reading comprehension (Table 5).

Results of this model indicated that despite positive correlations of working memory with reading comprehension in ELLs and EL1s, working memory had a significant but negative coefficient in explaining reading comprehension outcome. An examination of Table 4 revealed that the association of working memory with decoding was higher than its association with reading comprehension, both in ELLs, $z = 3.76$, $p < .001$ and in EL1s, $z = 3.22$, $p < .001$. Similarly, the association of working memory with word reading was higher than its association with reading comprehension, both in ELLs, $z = 2.12$, $p = .01$ and in EL1s, $z = 2.06$, $p = .02$. These differences pointed to a possible suppression effect

Table 4. Correlations among Grade 4 cognitive, language and word-level reading measures, and Grade 6 reading comprehension in English language learners (ELLs; bottom diagonal) and EL1s (top diagonal).

	1	2	3	4	5	6	7	8	9	10	11
1. Working memory	–	.25**	.44**	.29**	.16	.20*	.18*	.48**	.37**	.15	−.11
2. Phonological memory	.30**	–	.43**	.18*	.23**	.32**	.14	.41**	.41**	.47**	−.29*
3. Phonological awareness	.47**	.40**	–	.46**	.37**	.33**	.39**	.73**	.64**	.48**	−.10
4. Naming speed	.31**	.17**	.43**	–	.19*	.06	.18*	.53**	.49**	.31**	−.20
5. Vocabulary	.36**	.34**	.52**	.29**	–	.28**	.46**	.33**	.30**	.52**	−.18
6. Syntax	.42**	.29**	.44**	.27**	.57**	–	.18*	.37**	.28**	.41**	.30*
7. Listening comprehension	.27**	.17**	.42**	.32**	.56**	.45**	–	.33**	.34**	.42**	.20
8. Pseudoword decoding	.52**	.31**	.73**	.54**	.42**	.53**	.33**	–	.82**	.52**	−.05
9. Word recognition	.43**	.38**	.74**	.49**	.48**	.45**	.38**	.81**	–	.46**	−.06
10. Reading comprehension 6	.30**	.39**	.49**	.34**	.54**	.49**	.46**	.50**	.60**	–	−.46**
11. Reading comprehension.Slp	−.04	−.11	−.08	−.06	−.16	.12	.13	−.08	−.06	−.24*	–

Slp, Slope; *Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed).

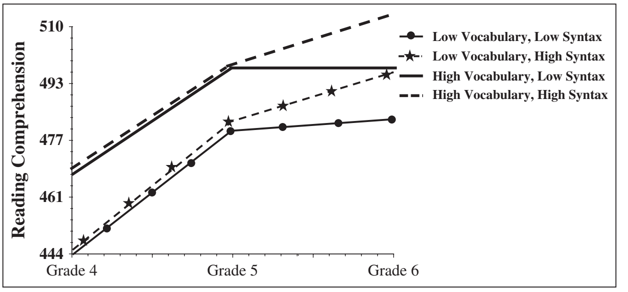

Figure 2. Estimated mean growth of reading comprehension as a function of poor and good vocabulary and syntactic knowledge.

(Cohen & Cohen, 1983; Krus & Wilkinson, 1986). Therefore, to obtain a more parsimonious model and to enhance ease of interpretation, working memory was removed from the combined model with Grade 4 predictors.

Results of this analysis indicated that when entered into the model simultaneously, phonological short-term memory, all three aspects of oral language (vocabulary, syntax and listening comprehension) and word recognition made significant independent contributions to reading comprehension outcome. It is noteworthy that in spite of shared variance among the oral language measures, all three aspects of oral language remained independent predictors of subsequent reading comprehension. Phonological short-term memory and syntax contributed positively to rate of growth in reading comprehension. In addition, the interaction of syntax with vocabulary contributed negatively to reading comprehension rate of growth. The combined model predicting growth parameters of reading comprehension on the basis of Grade 4 predictors explained 71% of the variance.

Discussion

In this study, we examined reading comprehension in upper elementary ELLs and EL1s from two complementary perspectives – growth patterns and outcome. Studying growth patterns provides an opportunity to examine untested assumptions about growth in various skills and can point to factors that influence this growth. To date, the SVR model has not been examined with regard to the rate of growth in reading comprehension in monolingual or L2 learners. In this study, we explored the contribution of various components of word-level reading and oral language, as well as that of cognitive processing skills to the reading comprehension rate of growth and outcome. Studying early and later predictors of outcome and of rate of growth provides a more nuanced perspective on the nature of factors that underlie reading comprehension at different stages of development. In what follows, we elaborate on these topics.

Growth trajectories of reading comprehension in ELLs and EL1s

Two general observations can be made with regard to developmental patterns of reading comprehension in ELL and EL1 students from Grade 4 to Grade 6. The first observation concerns patterns of development in EL1s and ELLs. In this study, we found that reading comprehension skills improve gradually in ELLs and EL1s alike. However, it appears that the reading comprehension growth patterns of ELLs and EL1s are not identical – they are

Table 5. Early and late predictors of rate of growth in reading comprehension and Grade 6 reading comprehension: final fitted models.

	Fixed effect		Random effect			
	Coefficient	*SE*	Variance	*SD*	Deviance	
Unconditional growth model					16876.94	
Reading comprehension 6	497.69***	2.42	2004.75***	44.77		
Linear	1.07	.23				
Non-linear	−0.04***	.01				
	Early predictors			Late predictors		
	Fixed effect		Random effect	Fixed effect		Random effect
	Coefficient	*SE*	Variance	Coefficient	*SE*	Variance
Combined conditional models						
Reading comprehension 6[a]	500.83***	3.34	723.04***	498.71***	2.73	583.23***
ELL	−6.04	3.95		−2.29	3.11	
Nonverbal ability	−0.28	0.21		–	–	
Working memory	2.87*	1.37		–	–	
Phonological	0.91*	0.42		3.46***	0.55	
Phonological awareness	1.51***	0.50		0.05	0.47	
Naming speed	6.52	4.67		−0.37	2.81	
Vocabulary	0.26	0.15		0.65***	0.13	
Syntax	2.41***	0.42		1.31***	0.39	
Listening comprehension	0.95**	0.35		2.43***	0.38	
Vocabulary × Syntax	0.02	0.02		−0.02	0.02	
Decoding	−0.77	0.33		0.32	0.26	
Word recognition	−0.11	0.51		2.49***	0.40	

(*Continues*)

Table 5. (Continued)

	Fixed effect		Random effect			
	Coefficient	*SE*	Variance	*SD*	Deviance	
Reading comprehension 2[a]	2.18***	0.22		–	–	
Linear						
ELL	−0.07	0.19		−1.35*	0.40	
Nonverbal ability	0.00	0.01		–	–	
Phonological memory	–	–		0.18*	0.07	
Naming speed	0.26	0.39		–	–	
Vocabulary	0.00	0.01		−0.03	0.01	
Syntax	0.23***	0.05		0.13**	0.05	
Vocabulary x Syntax	−0.00	0.00		−0.01*	0.00	
Non-linear						
ELL	–	–		−0.01	0.02	
Phonological memory	–	–		0.01	0.00	
Naming speed	0.02	0.02		–	–	
Vocabulary	−0.00	0.00		−0.00	0.00	
Syntax	0.01***	0.00		0.01***	0.00	
Vocabulary × Syntax	−0.00	0.00		−0.00	0.00	
Deviance			16428.49			16323.75
ΔR^2			64%			71%

[a]Numbers 2 and 6 refer to the respective grade levels.
*Significant at the 0.05 level; **Significant at the 0.01;***Significant at the 0.001.

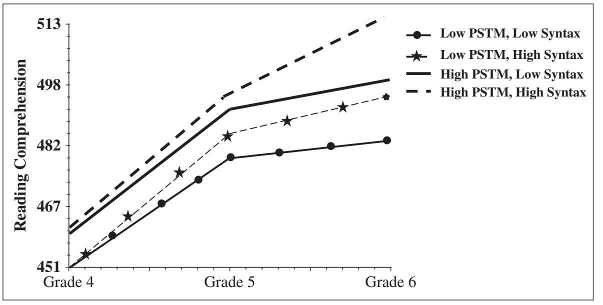

Figure 3. Estimated mean growth of reading comprehension as a function of poor and good syntactic knowledge and phonological short-term memory.

linear in EL1s but non-linear in ELLs. The pattern in the EL1s is unlike the finding of Catts et al. (2008), who reported a deceleration in the rate of reading comprehension growth in monolingual students. The differences between the study of Catts et al. (2008) and the present findings may be due to differences in sample characteristics, or the nature of the reading comprehension measures used in these two studies (Francis et al., 2006; Keenan et al., 2008; Lervåg & Aukrust, 2010). The non-linear pattern characterising the ELLs, in which growth in reading comprehension slows down, has also been reported in other studies involving ELLs (e.g., Mancilla-Martinez et al., 2011; Nakamoto et al., 2007).

The second observation concerning developmental patterns is that there is a significant gap in reading comprehension between ELLs and EL1s. More precisely, not only do EL1s outperform ELLs at each grade level but also the gap between the ELLs and EL1s expands so that it is larger in Grade 6 than in Grade 4. Important questions that require further longitudinal investigation include the extent to which the gap in growth in reading comprehension can be narrowed over time with well-designed preventative instruction. It is also important to examine the generalisability of these findings to different groups of L2 learners, including those who are first exposed to the L2 when they are older. As noted previously, it is also important to examine the extent to which these findings hold with different measures of reading comprehension.

Predictors of rate of growth in reading comprehension in an augmented SVR framework

Not much is known on whether the SVR model, augmented or not, is useful for understanding growth in reading comprehension trajectories. Results of this study suggest that a key element of the SVR, accuracy in word reading, does not predict growth in reading comprehension, whether assessed in early or in upper elementary grades. This is the case for ELL and for EL1 learners, alike. It is possible, however, that individual differences in word reading fluency may be related to distinct growth pattern trajectories in reading comprehension. Further research is required to examine this conjecture.

At the same time, the findings confirm that language comprehension is related to growth in reading comprehension; however, it is not vocabulary but rather syntactic knowledge that predicts growth trajectories in reading comprehension. Complex tasks such as judging syntactic accuracy require listening, holding linguistic information in working memory, processing larger chunks of linguistic information and integrating prior knowledge may be more demanding cognitively than a receptive vocabulary task. The result suggest that only more complex language tasks that capture various underlying cognitive and linguistic processes can predict growth in reading comprehension. In this respect, it might be that the Peabody Picture Vocabulary Test–Revised used in this study to assess vocabulary knowledge is not sufficiently demanding, and therefore, it does not reliably predict growth in reading comprehension (Ouellette, 2006; Tannenbaum, Torgesen & Wagner, 2006).

Syntactic knowledge appears to be a stable predictor of the rate of growth in reading comprehension in both ELLs and EL1s. In fact, already in Grade 1, it is possible to identify individual differences on this language skill that are related to subsequent growth in reading comprehension. That is, notwithstanding language status, students with relatively stronger syntactic knowledge are more likely than students with weaker syntactic knowledge to show steeper growth in reading comprehension in upper elementary grades.

The findings regarding the long-term contribution of syntax to the rate of growth in reading comprehension are consistent with the study of Nakamoto et al. (2007) of Spanish-speaking ELLs. In that study, lower scores in Grade 1 on an oral language construct (which combined receptive vocabulary and sentence recall) were associated with slower growth rates in reading comprehension in upper elementary grades. In the present study, however, when considered on its own, vocabulary knowledge is related (negatively) to growth in reading comprehension. However, when considered jointly with syntax, vocabulary is no longer a unique predictor of rate of growth in reading comprehension, but syntax is. It is possible that in the study of Nakamoto et al. (2007), the use of an amalgamated language construct rather than distinct language components has masked the manner in which vocabulary and syntax might have contributed to reading comprehension.

The current study indicates that the positive effect of syntactic skills appears to mitigate the negative effect of vocabulary knowledge on reading comprehension rate of growth. These results are illustrated in Figure 2, in which the mitigating effect of syntax is noted with regard to the group that has low vocabulary but high syntax, and with regard to the group that has high vocabulary but low syntax. In particular, note that starting in Grade 5, in the case of the group that has low vocabulary but high syntax, the reading comprehension trajectory is steeper than in the other groups. On the other hand, the trajectory associated with the group that starts with relatively high vocabulary but has low syntax begins to plateau.

As for the cognitive correlates of the reading comprehension growth, it is important to note that although cognitive measures assessed early do not predict growth in reading comprehension, by Grade 4, phonological short-term memory emerges as a positive predictor of rate of growth in reading comprehension. That is, the reading comprehension trajectories of students with stronger phonological short-term memory are likely to be steeper than those of students with lower phonological short-term memory. In other words, prediction of growth in reading comprehension is augmented when individual differences on phonological short-term memory are considered as well.

The positive contribution of phonological short-term memory to reading comprehension rate of growth can be discussed from two complementary theoretical perspectives. Previous studies with young children (ages 6 to 10 years) with a history of specific language impairment did not find any correlation between a measure of nonword repetition and syntax (e.g., Bishop, Adams & Norbury, 2006; Norbury, Bishop & Briscoe, 2001). The researchers argued that the lack of significant correlation indicates that the two constructs have independent origins. In this study, we found low but positive correlation between phonological short-term memory and syntax and between these two variables and reading comprehension. It is interesting that in spite of low correlations, these two variables made unique contributions to reading comprehension growth. Therefore, it is possible that the association between these two variables may change as a function of age and the qualitative developmental changes in the variables themselves. The unique contribution of these two variables to reading comprehension indicates that although these two variables are independent from one another, similar underlying cognitive process may drive the association of these constructs with reading comprehension (e.g., Bishop, 2006; Gathercole, 2006). Figure 3 shows graphically the mutual facilitation of phonological short-term memory and syntax in their contribution to reading comprehension. A second perspective is in line with the recent research in neuroscience that examines the brain activities under high processing verbal load. This research indicates that when processing syntactically complex sentences, the brain recruits verbal working memory. That is, the articulatory rehearsal component of verbal working memory drives the effect of syntactic complexity and facilitates the comprehension of complex sentences (e.g., Caplan, Stanczak & Waters, 2008; Rogalsky, Matchin & Hickok, 2008).

The present study highlights the role of individual differences in growth in reading comprehension. It shows that some ELL and some EL1 learners develop their reading comprehension skills in a more laborious manner and that this pattern is related, to some extent, to underlying processing skills such as phonological short-term memory and language skills such as syntactic knowledge. Additional research is needed to examine the contribution of other measures of vocabulary and syntax to growth in reading comprehension. Research is also needed to determine the influence of developmental, contextual, typological and home literacy variables on growth in reading comprehension.

Predictors of reading comprehension outcome in an augmented SVR framework

This study provides support for the SVR to the extent that variables forming the word recognition and language comprehension clusters predict reading comprehension longitudinally, in ELLs and EL1s alike. More specifically, individual differences on word recognition and language comprehension components, assessed at the beginning of formal schooling (Grade 1) or in later years (Grade 4), predict reading comprehension in Grade 6.

At the same time, this study also provides evidence for the value of an SVR model that is augmented by various cognitive processes. In particular, we found that phonological awareness, naming speed and working memory were significant early predictors of reading comprehension in Grade 6. However, performance on these three variables in Grade 4 did not contribute to Grade 6 reading comprehension. This finding is in line with other research (e.g., Yaghoub Zadeh et al., 2012) that has shown that the relationship between phonological awareness, and naming speed and later performance on reading comprehension is mediated through word recognition skills. Of note is the emergence of Grade 4 phonological short-term memory as a highly significant underlying cognitive process that predicts reading comprehension in Grade 6. This finding is commensurate with other studies that have shown that phonological short-term memory is implicated in language development. For example, Farnia and Geva (2011) have shown that phonological short-term memory predicts vocabulary knowledge and rate of growth in vocabulary of ELLs and EL1s. It has also been implicated in studies that focused on the development of expressive vocabulary and syntactic skills of monolingual children with language impairment (e.g., Bishop, Adams & Rosen, 2006; Conti-Ramsden & Durkin, 2007; Caplan et al., 2008).

A second theoretical perspective in relation to the emergence of phonological short-term memory as a later (Grade 4) predictor of Grade 6 reading comprehension outcome relates to the findings of studies showing that regardless of the type of information to be processed (phonological, lexical and grammatical), when the complexity or difficulty of the task increases, more storage capacity is required for further processing of the language stimuli. In this regard, Bishop, Adams and Norbury (2006) suggested that the influence of poor phonological short-term memory on syntactic difficulties is not related to the acquisition of linguistic knowledge but to the on-line processing of verbal information. Similarly, Bishop, Adams and Rosen (2006) reported that difficulties in reading comprehension performance are not related to difficulties in syntactic knowledge per se but to limited processing capacity that hinders children's ability to compute meaning. In line with this research, the current study shows that regardless of home language, it appears that phonological short-term memory captures individual differences in oral language and reading comprehension.

In sum, our findings provide support for the value of an augmented SVR model that includes cognitive processes. These cognitive processes are distinct, and their contribution to reading comprehension varies at different times in a manner that reflects developmental changes in reading and language comprehension of ELLs and EL1s.

The role of components of oral language in an augmented SVR

In this study, three aspects of oral language skills were examined: receptive vocabulary, syntactic knowledge and listening comprehension. Findings of this study suggest that to better understand reading comprehension of monolinguals and ELLs alike, it is important to consider various components of oral language proficiency, which form part of the language comprehension cluster of an augmented SVR model. Even though these language skills share considerable variance, they each make unique contributions to ELLs' and EL1s' reading comprehension longitudinally.

Although it is to be expected that ELLs will have less well developed oral language skills than EL1s, of note is the fact that already in Grade 1, it is possible to capture individual differences in vocabulary, syntax and listening comprehension skills of ELLs that underlie and perhaps drive subsequent reading comprehension. As noted by others (Cunningham & Stanovich, 1997; Nagy, 2005; Stanovich, 1986), the relationships between linguistic knowledge and reading comprehension are mutually enhancing over time. Students who are better able to read and comprehend text subsequently acquire additional language skills and are exposed to increasingly complex novel linguistic structures, all of which, in turn, further enhance their reading comprehension skills.

Conclusion

In this study, we tracked the developmental trajectories of EL1 students and ELLs, with a range of home language backgrounds, who have had systematic exposure to oral and written English since Grade 1. These groups do not differ on cognitive skills, nor do they differ on word-level reading skills. At the same time, even though the ELLs develop their English oral language skills over time, they continue to have consistently poorer command of various components of English than their monolingual counterparts, and they continue to comprehend English texts less well than their monolingual peers. The findings underscore the importance of focusing on enhancing grade-appropriate vocabulary, syntactic skills and listening comprehension skills in students who appear to be fluent in conversational English but whose language skills lag in subtle but crucial ways behind their monolingual peers.

Not only do EL1s outperform their ELL counterparts at each grade level but also the reading comprehension trajectories of EL1s are linear, whereas those of ELLs slow down so that the gap between the two groups does not narrow. In spite of the ELL–EL1 differences, similar cognitive and language skills appear to drive development over time. Regardless of language status, those students who have better command of various aspects of English and of cognitive skills end up having better developed reading comprehension in subsequent years. In general, the use of an augmented SVR model generates a more complex but accurate picture of the factors that underlie reading comprehension in monolingual and ELL students.

There are various unanswered questions that emerged from this study that warrant further research. These include the need to investigate multiple pathways in the growth trajectories of reading comprehension in ELLs and EL1s, and to explore different combinations of predictors that might underlie these patterns (Parrila et al., 2005). To establish the generalisability of the findings, the results need to be replicated with groups of ELLs with different demographic and educational experiences. Moreover, additional research using measures that vary in complexity and task demands is needed.

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Notes

1. It should be noted that raw scores were used for other standardised tasks such as Digit Span, PPVT-R, Word Attack, WRAT Reading and WRAT Spelling to eliminate the possible effect of task standardisation that did not include ELL learners. For the Gates-MacGinitie Test of Reading Comprehension (GMRT), Extended Scale Scores (ESSs) were used to show progress over a period of years on a single, continuous scale.
2. Note that at the time when this longitudinal study was launched, standardised commercial measures of phonological processing such as the Comprehensive Test of Phonological Processing (Wagner, Torgeson & Rashotte, 1999) were not available.
3. The low reliability on listening comprehension in the EL1 group may be related to the fact that this task could be less challenging for the EL1s than the ELLs because of the formers' better developed language proficiency. In other words, the task was reliable enough to capture variability in ELLs. However, it did not seem to be sensitive enough to capture variability in EL1s.

4. We thank Guanglei Hong for suggesting that because we have only three measurement points, it is preferable to draw lines from one measurement point to the next rather than representing the results visually as growth curves.
5. The explained variance is the ratio of the difference between total parameter variance, or the variance of the true mean (obtained from the unconditional model) and the residual parameter variance (obtained from the fitted conditional models) to the total parameter variance (Raudenbush & Bryk, 2002).

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Appendix A: Cognitive, reading and language skills assessed at each measurement point

Measures	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Nonverbal ability (MAT)	✓	–	–	–	–	–
Working memory–digit span	✓	✓	✓	✓	✓	✓
Phonological short-term memory	✓	✓	✓	✓	✓	✓
Phonological awareness	✓	✓	✓	✓	✓	✓
Naming speed (RAN letters)	✓	✓	✓	✓	✓	✓
Pseudoword decoding (word attack)	✓	✓	✓	✓	✓	✓
Word recognition (Wide Range Achievement Test reading)	✓	✓	✓	✓	✓	✓
Receptive vocabulary (Peabody Picture Vocabulary Test)	✓	✓	✓	✓	✓	✓
Grammatical judgement	✓	✓	✓	✓	–	–
Listening comprehension	✓	✓	✓	✓	–	–
Reading comprehension (GMRT)	–	–	–	✓	✓	✓

Appendix B: Frequency and percent age of data available for 1–6 waves of data collection in the ELL and EL1 groups

Available data	Six times		Five times		Four times		Three times		Two times		One time	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
ELL	23	11	21	27	13	15	51	50	47	49	43	50
%	(67.6)	(32.4)	(43.8)	(56.3)	(46.4)	(53.6)	(50.5)	(49.5)	(49)	(51)	(46.2)	(53.8)
EL1	4	10	3	13	3	7	24	22	9	17	18	23
%	(28.6)	(71.4)	(18.8)	(81.3)	(30)	(70)	(52.2)	(47.8)	(34.6)	(65.4)	(43.9)	(56.1)

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