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Reading Comprehension in Adolescent First and Second Language Learners: A Comparison of Simple and Multi-Component Models

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READING COMPREHENSION IN ADOLESCENT FIRST AND SECOND LANGUAGE LEARNERS: A COMPARISON OF SIMPLE AND MULTI-COMPONENT MODELS

By

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ABSTRACT

The underlying components of reading comprehension were examined and compared in adolescents who spoke English as their first (L1) or second (L2) language. One-hundred and nine adolescents (55 L1 and 54 L2) completed measures of reading comprehension, decoding, vocabulary knowledge, working memory, comprehension strategy use, motivation and print exposure in English. Overall English L1 students outperformed English L2 students on measure of reading and language, with English L2 students performing below grade level on measures of comprehension and vocabulary knowledge. Examining models of reading comprehension between groups revealed that vocabulary knowledge is the best predictor of reading comprehension for both groups. In addition, decoding and working memory were significantly related to reading comprehension for English L2 students, while working memory and comprehension strategies were significantly related to reading comprehension for English L1 students. Furthermore, vocabulary knowledge mediated the relationship between motivation and print exposure with reading comprehension for English L1 students. For English L2 students, the relation between motivation and comprehension was mediated by comprehension strategies. For both groups comprehension strategies mediated the influence of decoding on comprehension. The applicability of using L1 models of reading with L2 populations, similarities and differences in the reading comprehension models, and implications for education instruction, are discussed.

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Having functional language and literacy skills is a vital component of educational and occupational success on micro and macro societal and economic scales, because literacy is a readily available resource to learn new skills and enhance knowledge (Chall, 1983; Coulombe & Trembley, 2005; Statistics Canada, & Organization for Economic Cooperation and Development, OECD, 2005). Low levels of literacy are associated with low job skills and low rates of employment and job skills requirements. One half of unemployed Canadians, 16-65 years old, have literacy levels unfit to learn new job skills and comprehend moderately complex text (Statistics Canada, & Organization for Economic Cooperation and Development, OECD, 2005). Investment in education as a poverty reducing strategy enables citizens to enhance life and job skills, and to live and work with dignity.

A 1% rise in a country's average literacy level, relative to the international average, is associated with an eventual 1.5% rise in per capita Gross Domestic Próduct (GDP) and 2.5% rise in labour productivity (Coulombe & Trembley, 2005). In OECD countries, differences in the average level of literacy explain 55% of differences in long term growth rates of GDP and labour productivity (Murray, McCracken, Willms, Jones, Shillington, & Strucker, 2009). Without literacy humans do not develop to their fullest capacities, continued learning is impeded, and the quality of life and the ease of survival are greatly diminished (Bennett, 2005).

The OECD, together with Statistics Canada, distributed the Adult Literacy and Life Skills Survey (ALL) in several counties, including Canada, to identify the literacy levels of citizens around the world. Scores on the prose and document literacy measures can be categorized into five levels. Levels 4 and 5 represent advanced literacy skills and a competency to integrate and make inferences from complex material. Level 3 is equivalent to high school completion and is usually the minimum desirable threshold to learn job skills and deal with the changing demands of a knowledge-based economy and society. Levels 1 and 2 represent very low to low literacy levels. Reading simple and clearly laid out information can be accomplished; however complex or dense material that requires a higher level of literacy cannot be comprehended (Statistics Canada & OECD, 2005.

In Canada, forty percent of adults, aged 16 to 65, are literate below Level 3. Of the 9 million, 3 million were Level 1 readers, equivalent to reading below a 5th grade level. Six million were Level 2 readers, equivalent to reading below the high school level. Furthermore, 60% of the people who have low literacy levels are immigrants learning English as a second language (L2), compared to 37% of native born individuals with low literacy (Statistics Canada & OECD, 2005). Findings from the Ontario Secondary School Literacy Test (OSSLT) also produce a concerning portrait of the literacy skills of adolescents, especially those learning English as their L2. From 2006-2008, 16% of students who spoke English as their first language (L1) failed the OSSLT and were required to retake and pass the test to be eligible to graduate. In 2008, 41% of English L2 learners failed the OSSLT. Also in 2008 there were an additional 50,000 students who were re-writing the test with only 31% of the students retaking the test who passed that year (Educational Quality and Accountability Office, EQAO, 2008). The current state of literacy skill in Canada is far from ideal. Many adolescents and adults need support to increase their literacy levels.

Past research has demonstrated that adolescent L2 learners, 12-15 years-old, had greater difficulty reaching average levels on standardized measures of academic achievement, when compared to L2 learners who were 5-7 or 8-11 years-old (Collier, 1987). On average it takes 6-8 years of schooling to reach average levels on standardized measures of academic achievement and to gain proficiency in academic English (Collier, 1987; Cummins, 1984). Given these constraints, scores on standardized tests in the United States and Canada show that adolescent English L2 learners have the lowest likelihood of achieving grade level reading scores; with fewer L2 learners than English L1 speakers achieving scores at or above grade level on state or provincial tests of reading comprehension and writing (Cummins, 1997; EQAO, 2008; Hoffman & Sable, 2006; U.S. Department of Education, 2006).

Research understanding the process of reading comprehension in second language adolescents is virtually non-existent. In order to help fill the knowledge gap, the following project examined how different components contribute to reading comprehension performance (i.e., decoding, vocabulary knowledge, working memory, comprehension strategies, reading motivation and print exposure). Implications of research based practices to help foster the reading skills of English L1 and L2 learners are discussed.

Research Questions

In this project we examined the relations between reading comprehension, decoding, vocabulary knowledge, working memory, comprehension strategies, interest in reading, and exposure to print in adolescents who are learning English as their L1 or L2. We examined models of English L2 reading comprehension in comparison to English L1 reading comprehension noting similarities and differences. Models were examined to establish if English L1 models can explain English L2 reading comprehension.

The general research questions of this project are:

1) Does the Simple View of Reading model (SVR; Gough & Tunmer, 1986) provide reasonable fit for explaining individual differences reading comprehension performance in English L1 and L2 adolescents?

2) Does the four component model (4C), which includes decoding, vocabulary knowledge, working memory and comprehension strategies as components, (Cain, Oakhill, & Bryant, 2005) provide better fit for explaining English L1 and L2 reading comprehension than the SVR?

3) What are the roles of interest in reading (reading motivation) and print exposure in the reading skills of English L1 and L2 adolescents?

The following sections reviewed studies of reading development in L1 and L2 speaking children and adolescents. Identifying the known role of cognitive and social components in reading will provide a sound base for outlining specific predictions and hypotheses.

Literature Review

Cognitive components in reading comprehension development

A componential analysis of reading comprehension performance has been beneficial in outlining and understanding the complex processes involved in reading comprehension (Tunmer & Hoover, 1992). In a componential analysis, reading comprehension is explained by performance on tasks assumed to measure constituent components of the reading comprehension process. The reading comprehension processes can be generally organized into lower-order (bottom-up) or higher-order (top-down) processes. Lower-order processes include letter-sound identification, word recognition, and syntactic parsing. Higher-order processes include applying knowledge to text and using strategies to perform text interpretation (Clark & Uhry, 1995; Tunmer & Hoover, 1992; van Gelderen, Schoonen, Stoel, Glopper, & Hulstijn, 2007).

Jeanne Chall (1983) outlined reading as a progressive process with stages that lead to the development of the cognitive components used to read. Generally speaking, stages 0-2 were categorized as a period where children are *learning to read* (Chall, 1983). Within the learning to read phase, children begin to understand the relationships between written and spoken words, as well as, between pictures, print and meaning. Two critical and fundamental skills that emerge in the *learning to read* stage are: (1) using knowledge that individual sounds comprise oral and written words and (2) the ability to translate visual information into an auditory (phonological) code; these skills have been labeled phonological processing and decoding respectively (Lesaux & Geva, 2006).

Phonological processing and decoding

Extensive evidence has shown that fluent and accurate phonological processing abilities play a critical role in reading acquisition and comprehension in native speakers and second language learners (Gottardo, Chiappe, Yan, Siegel, & Gu, 2006; Gottardo & Mueller, 2009; Gotttardo, Yan, Siegel, & Wade-Woolley, 2001; Geva & Yaghoub-Zadeh, 2006; Lafrance & Gottardo, 2005; Lesaux & Geva, 2006; Stanovich & Siegel, 1994; Tunmer & Hoover, 1992; Wagner & Torgesen, 1987). Specifically there are three different aspects of phonological processing that contribute to successful reading acquisition and comprehension: phonological awareness, phonological recoding in lexical access, and phonetic recoding in working memory. *Phonological awareness* is the awareness of the sound structure of a language; it is the ability to identify parts of speech such as syllables or phonemes. *Phonemic awareness* - a sub-skill of phonological awareness - refers the understanding that spoken words are represented by individual units of sound. *Phonological recoding in lexical access* is the process where written words or pictures are converted into a phonological code to access meaning. *Phonological* *memory* refers to storing information in a phonological code in working memory or short-term memory (see *working memory* for review). All phonological processing skills are related to reading but phonological awareness seems to be the strongest predictor (Lafrance & Gottardo, 2005; Lesaux & Geva, 2006).

Decoding and phonological processing are two intertwined constructs. Phonological processing skills are used during the decoding of unfamiliar words. Decoding is a word-level (lower-level) skill that refers to the knowledge of the spelling-sound (grapheme-phoneme) correspondence rules of English. Grapheme-phoneme correspondence (GPC) knowledge is used to transfer a novel word's orthographic form into a phonological representation to aid text comprehension or word learning. A child who has good decoding abilities will possess more knowledge about spelling-sound correspondences than a child who has poor decoding ability (Hoover & Gough, 1990). Good decoders will be able to activate phonological representations from print better than poor decoders. Decoding is a central component to reading comprehension but decoding alone is not sufficient for competent reading (Gough & Tunmer, 1986; Hoover & Gough, 1990).

The Simple View of Reading

The Simple View of Reading (SVR, Gough & Tunmer, 1986; Hoover & Gough, 1990) claimed that "reading (RC) equals the product of decoding (D) and listening comprehension (LC) (RC = D x LC), where each variable ranges from 0 (nullity) to 1 (perfection)" (Hoover & Gough, 1990, pg. 7). Both skills need to be partially developed (i.e., greater than 0) for reading comprehension to occur. Both decoding and listening comprehension are independent and interactive components of reading comprehension, but neither is sufficient for reading by itself.

Listening comprehension is a process where sentence and discourse information are interpreted when the lexical (i.e., word-level) information is decoded. The SVR claims that when printed material is decoded the reader will apply the same mechanisms to interpret text and spoken language. Listening comprehension is defined as a general language comprehension capacity. Often oral measures of sentence comprehension and vocabulary knowledge are used to assess listening comprehension in children. For the purposes of this investigation diverse measures of vocabulary knowledge were used to assess the student's general language comprehension. Measures of vocabulary knowledge and listening comprehension are related constructs. However, vocabulary knowledge has a robust relationship with reading comprehension, in comparison to the relation between reading comprehension and listening comprehension (Ouellette & Beers, 2009; Wise, Sevcik, Morris, Lovett, & Wolf, 2007). For the L2 sample presenting orally administered sentences or passages for measuring listening comprehension may present a confound in the measurement of the listening comprehension. Individual differences in English speech perception and working memory capacity will influence the results. Therefore, we chose to use vocabulary knowledge as an approximation for listening comprehension because it acts as a purer measure of comprehending linguistics units, with a reduced memory load and less reliance on correctly perceiving multiple units of speech.

The SVR predicted that early in reading development D and LC are positively correlated with reading comprehension performance; however the correlation between D and LC is non-significant. Later in reading development the relationship between LC and RC becomes stronger than the relationship between D and RC. As well, the relationship between D and LC becomes significant. The SVR was confirmed in samples of normally achieving and reading disabled monolinguals (Gough & Tunmer, 1986) and longitudinally, from first-to-fourth grade, with English-Spanish bilinguals (Hoover & Gough, 1990). However the SVR has not been tested in adolescent English L2 learners. A purpose of the current study is to clarify if the SVR can adequately explain reading comprehension in English L2 adolescents.

Listening comprehension is synonymous with oral language proficiency because both refer to an umbrella construct that incorporates vocabulary knowledge, morphological awareness and grammatical knowledge (Geva, 2006). Teasing apart the components within oral language proficiency illuminates the cognitive mechanisms at work during listening comprehension, and describes the specific language skills needed for competent reading. After reviewing existing empirical studies, Kirby and Savage (2008) concluded that the SVR does a reasonable job explaining individual differences in reading comprehension ability. However, there are gaps in research that used the SVR as a theoretical framework. They concluded that research with L2 populations, a deeper exploration into the conceptualization of decoding and listening comprehension, the measurement of reading comprehension, the role of comprehension strategies, and reading fluency are vital areas in need of investigation.

As an empirical example of the "not so simple" SVR, Savage (2006) tested fifty-six English L1 adolescents (*M* age = 15 years 2 months) with reading disabilities. All students had reading related performance below an age equivalence of 10 years old in one aspect of literacy and normal cognitive skills on tasks of nonverbal reasoning. To measure comprehension, adolescents read a series of prose passages aloud and a set of comprehension questions were presented orally afterwards. Adolescents read a list of single and multisyllabic nonsense words as a pure measure of decoding skill (e.g. pove, lobule, monglustamer). Nonsense words (non words) are reasoned to be a pure measure of decoding because prior word knowledge cannot facilitate identification of the highly novel nonwords. To measure listening comprehension the participants were read a series of narrative passages increasing in complexity, and then were required to answer a series of comprehension questions. To measure vocabulary knowledge participants completed a word definition and verbal similarities task. These two measures were combined to form a "verbal ability" composite score.

The group of adolescents assessed had low-to-average verbal abilities and extremely poor performance on tests of reading accuracy, rate and comprehension. Savage confirmed that D and LC are independent constructs that are highly relate to RC in adolescent poor readers, as long as nonword reading was used to measure D. If text-reading accuracy was used to index D, it was verbal ability not LC that explained reading comprehension the best. The method of assessing decoding greatly affected the reading model that emerged. It is clear that there is shared variance between decoding, text reading, and verbal ability. Making a detailed componential analysis of reading comprehension is necessary to identify the constructs that share the most variance with reading comprehension.

In terms of developmental differences, early reading ability is best predicted by D, but as children develop, the relationship between LC and RC becomes statistically stronger than the relationship between D and RC (Catts, Hogan & Adolf, 2005; Torgesen, Wagner & Rashotte, 1997). Catts et al. (2005) examined average and poor readers from 2nd to 8th grade and identified that in early grades individual differences in D were more strongly related to RC, than were the relations between of LC and RC. However, by 8th grade the majority of unique variance in RC was explained by LC. As readers matured word recognition became more automatic and less predictive of individual differences in reading comprehension ability. Simultaneously, the linguistic demands of text increased, causing readers to rely on word knowledge to comprehend text (Perfetti & Hart 2002; Perfetti, 2007: Verhoeven & Van Leeuwe, 2008).

In another study, Braze, Tabor, Shankweiler, and Mencl (2007) examined 44 adolescent and young adults (age range 16-24) with a wide range of reading abilities. The researchers examined if the SVR can capture all nonrandom variation in reading comprehension, and if orally assessed vocabulary knowledge accounted for additional variance in reading comprehension. Participants were administered tests of reading comprehension, decoding, phonological awareness, vocabulary knowledge, verbal working memory, listening comprehension, and experience with print.

The SVR gave a reasonable fit to the data with decoding ability clearly playing an important role in reading comprehension. However after controlling for the effects of D and LC, vocabulary knowledge predicted unique variance in reading comprehension. The researchers used the lexical quality hypothesis to explain how vocabulary knowledge assists reading comprehension.

Vocabulary knowledge and the lexical quality hypothesis

The *lexical quality hypothesis* (Perfetti & Hart, 2001; Perfetti, 2007) was based on the *connectionist model of word reading*. The connectionist model of word reading proposed that a network of separate groups of neuron-like units represents spelling (orthography), pronunciation (phonology), and meaning (semantics) (Seidenberg & McClelland, 1989). In other words, these specific layers are directly responsible for storing the different elements of words. During reading the processing of visual input activates units that correspond to a spelling pattern and activation then spreads to the output units (e.g., phonology, semantics). Processing information occurs in a *simple feedforward network* - activation flows in one direction. The decoding of unfamiliar words occurs through the activation of orthographic-to-phonological units, while highly familiar words are activated from semantic memory automatically (Seidenberg, 2005).

The lexical quality hypothesis (Perfetti & Hart, 2001; Perfetti, 2007) predicted that robust lexical representations positively contribute to the development and expression of reading skills. The quality of a lexical representation depends upon its strength of associative connections between semantic, phonological, and orthographic levels. A representation of high quality will have a fully specified spelling (orthography), a familiar phonological representation, and is linked to a semantic network. A large and specified lexical network helps facilitate automatic word identification which allows more cognitive resources to be allocated to comprehension. Lexical quality is assessed with receptive and expressive vocabulary measures because lexical representations represent detailed knowledge of word forms and meanings. We can consider high scores on vocabulary knowledge measures to be related to a lexical system of high quality.

Protopapas, Sideridis, Mouzaki, and Simos (2007) examined the shared variance between word-level reading skills (i.e., decoding), vocabulary knowledge and reading comprehension in 534 Greek children in Grades 2 through 4. It was predicted that the relationships between decoding and reading comprehension will be mediated by the lexicon. Furthermore, the influence of the lexicon will increase over time because the overall quality of the lexical representations positively contributes to successful reading.

Protopapas et al. found significant evidence supporting the lexical quality hypothesis in their sample of children. The effects of word-level skills on comprehension significantly decreased when vocabulary was entered into the hierarchical regressions, and this effect became more robust between Grades 2 and 4. The researchers suggested that the lexicon may be mediating the effects of decoding on comprehension, and over time the influence of the lexicon on comprehension appeared to increase.

Research has demonstrated that the development of vocabulary knowledge is important in reading comprehension and the relationship gets stronger over time. The acquisition of vocabulary knowledge itself needs to be understood in greater detail to identify additional cognitive mechanisms that contribute to reading comprehension. Also, understanding vocabulary acquisition provides insight into how the lexical quality hypothesis facilitates automatic word identification and reading comprehension. In order to do so a discussion of the third type of phonological processing *phonological memory* and its connection to working memory will commence.

Working memory

Working memory is a multi-component system that processes, stores, and recalls visual and verbal stimuli during learning, reading and problem solving tasks. The three components of working memory are the phonological loop, the visuospatial sketchpad, and the central executive (Baddeley, 1983). The phonological loop (or phonological memory) holds speech-based information for short periods of time. It has a phonological store, which maintains the phonological form of words, and an articulatory control process refreshes memory traces. The visuospatial sketchpad maintains and manipulates visual and spatial images. The central executive processes the information held in the phonological loop and visuospatial sketchpad by selecting and operating control and comprehension processes and strategies. The central executive functions with a limited capacity; if the information processed requires more cognitive resources than available the central executive functions with reduced efficiency and accuracy (Baddeley, 1983).

Research has show that individual differences in working memory capacity reflect differences in reading comprehension ability. Individual differences in working memory capacity could be the result of qualitative differences in the chunking process. Chunking recodes concepts and relations into higher-order or representative units. Even though chunking is initially cognitively demanding, it has a large payoff because it economizes storage capacity which helps to reduce working memory load and improve functioning. If decoding words in text reading requires excessive effort, few resources will be available for comprehension. Poor readers chunk less efficiently, reducing working memory capacity and processing power (Daneman & Carpenter, 1980).

Siegel and Ryan (1989) compared children with reading disabilities (RD), arithmetic disabilities, attention deficit disorder, and normal achievers. Children were administered tests assessing verbal working memory (i.e., digits span and sentence span), reading, math and spelling. Children with RD scored lower than all other groups on all measures, except the children with arithmetic disabilities who scored slightly lower on the math test than the reading disabled children. Results confirmed that children with RD have a generalized deficit in working memory.

There is strong agreement that RD children's verbal working memory is impaired, making it a critical component in the reading comprehension processes. However there is disagreement in the nature of the working memory deficit. Research examined the components of Baddeley's original working memory model in 20 reading disabled and 20 normally achieving children aged 9 to 13 years to address the debate (Kibby, Marks, Morgan & Long, 2004). The authors argue that children with reading disabilities have an intact visual-spatial sketchpad and central executive functioning, but they have an impaired phonological loop as compared to normal achievers. Furthermore the deficit appears to be specific to the phonological store. The articulatory control processes function adequately in children with RD (Kibby, Marks, Morgan & Long, 2004). In sum, children with reading difficulty often have trouble maintaining the phonological form of new words, which is may be due to inefficient chunking. As a result the phonological loop functions with reduced efficiency which disrupts reading comprehension and vocabulary acquisition.

The phonological loop and vocabulary acquisition

Baddeley, Gathercole and Papagno (1998) suggested the "phonological loop plays a critical role in learning the phonological form of new words" (pg. 168). The phonological loop stores unfamiliar sound patterns, while the central executive functions to create permanent memory traces. With repetition and sufficient exposure, the phonological forms of words become permanently stored in memory. However the researchers suggested that existing lexical knowledge and phonological working memory significantly contribute to learning the sounds of new words (Gathercole, Hitch, Service and Martin, 1997).

In 2006, Susan Gathercole reviewed word learning studies of both typical children and adults, with and without, disorders of language learning. Gathercole described that word learning and nonword repetition is strongest during the early stages of acquiring a language. As the lexicon develops it mediates learning by accessing phonological representations in long-term storage, this is known as the "lexicality effect", which is strikingly similar to the lexical quality hypothesis (Perfetti & Hart, 2001; Perfetti, 2007). As an individual learns more about a particular language the phonological code becomes more familiar. An individual does not rely only on the phonological loop for processing phonological information. The lexical system reconstructs incomplete representations held in the phonological loop by means of lexical activation. The phonological loop does not operate in isolation from permanent knowledge representations.

Nonword repetition ability is significantly constrained by the phonological loop's storage capacity. Phonological store capacity plays a key role in reading comprehension and learning the sound structure of new words. Knowledge of the phonological code of a language allows the individual to 'chunk' phonological information, which results in efficient storage and easier rehearsal (Gathercole, 2006). Phonological storage capacity increases with efficient and accurate phonological decoding. Therefore, efficient phonological processing requires few cognitive resources, leaving more resources available to create permanent memories of new word. In addition, efficient decoding of printed words allows more cognitive resources to be available for semantic retrieval and syntactic processing which benefits reading comprehension (Baddeley, Gathercole & Papagno, 1998; Gathercole, Hitch, Service and Martin, 1997).

The four component model and higher order comprehension skills

Cain, Oakhill and Bryant (2004) assumed that reading comprehension requires more processing factors than can be captured in the SVR. Their model will be referred to as the four-component model (4C) which examined (1) working memory (2) decoding (3) vocabulary knowledge (verbal ability) and (4) higher order comprehension skills as independent components. Decoding and working memory are considered to be lower-order processes and vocabulary and higher order comprehension skills are considered to be higher-order processes. Cain and colleagues followed 80 children longitudinally at ages 8, 9, and 11 years old to examine the relationship between working memory capacity, reading comprehension and the use of higher order comprehension strategies. Children's reading comprehension, word reading accuracy, vocabulary knowledge, verbal ability (oral vocabulary), working memory and comprehension strategies (i.e., inference and integration, comprehension monitoring, and knowledge of story structure) were assessed at 8, 9 and 11 years. The authors determined that working memory capacity explained unique variance in reading comprehension at all ages. Furthermore, comprehension strategies - specifically inference making and comprehension monitoring - made independent contributions to predicting reading comprehension, when controlling for lower level skills (word reading, vocabulary knowledge, and verbal ability).

Inference making is the construction of a meaning-based representation of a text by using referential coherence, causal antecedents, and character's emotional reactions. Making inferences is important in establishing global coherence in text. Comprehension monitoring is an error-detection meta-cognitive strategy that aids comprehension and the connection of prose. An individual with high comprehension monitoring will detect inconsistencies in text or notice comprehension failure. Explicit awareness about inadequate comprehension will lead a student to use higher order strategies or skills to correct comprehension. Interestingly, comprehension skills are not completely explained by the shared variance with working memory; there is a distinction between higher-order comprehension skills and lower-order (working memory) processing capacity. The 4C model that predicts reading comprehension has (1) working memory (2) decoding (3) vocabulary knowledge (verbal ability) and (4) higher order comprehension skills as independent components. The majority of the research presented so far describes the process of comprehending text in monolingual samples. Since the major objective of this project was to examine reading comprehension in L2 learners, a discussion of specific features of L2 reading is warranted.

Unique Features of L2 reading: Cross-linguistic transfer of L1 skills to L2 reading

An interesting field in language and literacy research is the study of cross-linguistic transfer of L1 to L2 skills, and vice versa. Hot questions are, what L1 language or literacy skills are related to L2 reading comprehension and how do L1 components fit into L2 models of reading? We wished to examine the influence of L1 skills on L2 reading comprehension but translating copies of standardized tests in Arabic, Farsi, and Mandarin, and the dozen other languages represented, are time consuming and difficult to develop and administer in the time frame allotted for this project. Even though cross-linguistic transfer is not being directly addressed with this proposal – instead we are examining the influence of English reading and language skills on English reading comprehension - rest assured that reading and language assessments for the most representative first languages (i.e., Mandarin, Cantonese, Spanish, and Farsi) are in development and will be used in a larger project.

Very little research has examined reading in adolescents learning English as a second language. Van Gelderen, Schoonen, Stoel, Glopper, and Hulstijn (2007) examined the relationship between reading comprehension development in 389 adolescent with Dutch as a L1 and English as a L2. In grades 8 through 10, student's reading comprehension, vocabulary and grammatical knowledge, and processing efficiency (speeded word recognition and sentence comprehension) were assessed in both languages. The authors tested the relationship between L1 and L2 reading with three hypotheses directing the research; the *transfer, threshold,* and *processing efficiency* hypotheses.

The transfer hypothesis claimed that the difference between the components (e.g., decoding or vocabulary) of L1 and L2 reading comprehension are negligible. L2 readers transfer their L1 reading skills during L2 reading. There are only slight shifts in accommodations to specific characteristics of L2 orthography and grammatical structure needed for using L1 skills in L2 reading. The threshold hypothesis claimed that L2 knowledge of vocabulary or grapheme-phoneme correspondence must develop to a certain threshold before L1 skills can transfer to L2 performance. Once the threshold of L2 reading is surpassed L2 reading becomes very similar to L1 reading. The processing efficiency hypothesis claimed that the efficiency of lower order processing is an important condition for reading comprehension in an L1 or L2. There is a limited working memory capacity that creates competition between lower- and higher-order skills. Efficient processing of lower-order information (e.g., word identification, decoding) allows more working memory capacity to be available for higher-order comprehension processing. A certain level of fluency or efficiency in processing lower-order information is necessary to allow adequate cognitive resources to be available for text comprehension and interpretation.

Van Gelderen et al (2007) found strong evidence for the transfer hypothesis because L1 and L2 reading comprehension were highly related to one another, and this relationship increased in strength and significance over time. It appears that L2 reading becomes more similar to L1 reading over time. Interestingly, meta-cognitive knowledge, or higher order processing, was represented as a separate component that contributed to both languages, rather than transferring from the L1 to the L2. Also, the researchers found evidence that language specific knowledge played a significant role in L2 reading comprehension. The results indicated that L2 vocabulary and grammatical knowledge uniquely predicted L2 reading comprehension, but not L1 reading comprehension. The results indicate strong evidence towards the transfer hypothesis and weak evidence supporting the threshold hypothesis.

Recent research has used theoretical models of reading comprehension of monolinguals to examine reading comprehension in L2 learners. Gottardo and Mueller (2009) tested the applicability of the SVR as a model of L2 reading comprehension in a longitudinal sample of Spanish speaking English language learners from the first to the second grade. Measures of phonological awareness, decoding, and oral language (i.e., vocabulary knowledge and grammatical judgment) were administered in Spanish and English. The measures of phonological awareness in the L1 and L2 were separate but related constructs. Also, L1 and L2 oral language skills were separate constructs. The validity of the SVR as a model of L2 comprehension was supported because decoding and oral language skills, particularly in English, were the strongest predictors of reading comprehension. Without decoding or oral language the model fit poorly and did not do adequate job of explaining performance in reading comprehension ability.

In another study, a sample of 85 Spanish (L1) – English (L2) children were administered a battery of word reading, phonological processing, and oral language measures in the first grade. The measures of phonological processing and reading were significantly related within and between languages (Gottardo, 2002). A similar design with very different sample found strikingly similar results. Gottardo, Yan, Siegel, and Wade-Woolley (2001) assessed reading, phonological, syntactic and orthographic processing skills in 65 Chinese (L1) – English (L2) children. Again, phonological awareness was correlated across L1 and L2 and both were correlated with L2 reading. Both studies suggest that regardless whether the L1 is an alphabetic or logographic writing system, the relations between L1 and L2 reading and the predicted outcomes of L2 reading are very similar in children who are receiving language instruction in English, their L2 (Durgunoglu, 2002; Genesee & Geva, 2006).

Although the previous research demonstrates that the relations between L1 and L2 reading skills are similar for students with diverse L1 backgrounds, the results are unable to identify if there are influences of the similarity between the L1 and L2 in terms of word identification and learning. Before addressing this topic a discussion of different orthographic representations - *alphabetic* and *logographic* writing systems - is warranted.

L1 Orthographic Representation and L2 Congruency

In an alphabetic writing system, letters represent phonemes. Words are defined by a string of letters each carrying phonemic information. An alphabetic writing system can be also be categorized as having a *shallow* or *deep* orthography, often referred to as *orthographic depth*. In shallow alphabetic orthographies, Spanish for example, the relations between letters and sounds (graphemes and phonemes) is regular, consistent, and therefore, transparent. In deep alphabetic orthographies, English for example, there are inconsistent and irregular relations between graphemes and phonemes (*e.g.*, save, gave, have – noting the pronunciation of /*a*/). Often morphological information is preserved at the expense of phonological transparency (*e.g.*, humm**ed,** walk**ed** – the former *ed* pronounced /*d*/, the latter pronounced /*t*/) (Hamada, & Koda, 2008; Oney, Peter, & Katz, 1997; Glushko, 1979). In a logographic writing system, Chinese for example, characters primarily correspond to morphemes. Chinese is considered a morpho-syllabic (morpheme to phoneme) system, where the first radical corresponds to the semantic-morpheme, and the second to the pronunciation in a one character word. For example, the semantic radical 立 means 'to stand' and the phonetic radical 占 means 'to occupy'. Usually, the pronunciation of the phonetic radical is relevant but the meaning is irrelevant (Lee, 2006; Perfetti, & Zhang, 1995). The hypothesis surrounding the congruency between a L1 and learning a L2 is that the acquisition of a L2 is facilitated by a L1 that is similar in terms of orthographic representation (alphabetic vs. logographic) and depth – the more congruent the easier it is to learn decoding skills and new words (Hamada & Koda, 2008).

Hamada and Koda (2008) examined the influence of L1 orthographic characteristics on L2 decoding and the retention of new words, to examine if the congruency of orthographic representation and depth moderate the relationships between L1 and L2 skills. The participants were college-level English L2 learners with similar (Korean – an alphabetic language) and dissimilar (Chinese – a logographic language) L1 backgrounds. Decoding ability was measured by a pseudoword naming task of phonologically irregular and regular conditions. Participant's recall of novel pseudowords paired with pictures was the measure of word learning. The Korean group showed faster performance on the pseudoword naming task, demonstrating that the congruency between the L1 and L2 systems can explain the Korean group's superior performance. However, the influence of L1 transfer is modest. It is the L2 input that had the most powerful impact on L2 decoding, than transferred L1 competencies. Also the Korean group had better overall retention of new pseudoword meanings, but greater impairment with the irregular pseudowords. The authors state that congruent L1-L2 orthographic experiences improve decoding efficiency which promotes the retention of word learning episodes. Also, irrespective of L1 background, L2 learners were more efficient at decoding regular words, compared against irregular words.

In summary, there are many cognitive variables that influence reading comprehension. An individual's working memory capacity, determined in part by the efficiency of phonological processing and storage is a critical feature in word learning and text interpretation. The SVR claims that being able to decode printed text to activate a phonological or semantic interpretation is incredibly important in literacy acquisition. In addition the quality of word knowledge has an impact on reading ability and can facilitate comprehension when decoding skills are weak. Furthermore, higher order comprehension strategies play an independent role in reading comprehension ability. It appears that cross-linguistic transfer of reading skills occurs for lower order processes (e.g., word identification, vocabulary knowledge), and higher order comprehension strategies act on a general language-independent level. Finally, the orthographic congruency between languages can account for some differences in the word reading abilities of L2 learners with diverse L1 backgrounds.

As mentioned at the onset of this paper, cognition does not occur within a vacuum. Social or environmental factors influence the development of language and literacy, and how language and literacy are expressed. To provide a comprehensive understanding of reading comprehension a *socio-linguistic* approach to studying language and literacy is presented to identify which social factors should be examined together with cognitive components.

Sociolinguistic Approach

The sociolinguistic approach focused on the impact of social factors on cognitive processes and how the acquisition of a second language is affected. The quantity and quality of second language input and processing of second language input affect linguistic use, choice, and development. Linguistic use, choice and development are socially mediated. The linguistic contexts that an individual experiences significantly contribute to the development of a second language by means of exposure to linguistic input. Examining language acquisition within a social context is necessary to form a deeper understanding of the cognitive and social factors that produce linguistic outcomes (Tarone, 2007).

Reading Motivation

Children's reading motivation and the amount and breath of reading was examined in 4^{th} and 5^{th} grade children (Wigfield & Guthrie, 1997). Questionnaires and diaries were used to assess reading amount and breath. Measures of motivation were administered twice over the school year and covered topics of self-efficacy and intrinsic-extrinsic motivations and goals. Reading motivation was found to be multi-dimensional, and intrinsic motivation was the strongest predictor of reading amount and breath (Wigfield & Guthrie, 1997). In other research, Guthrie and colleagues (2007) used multiple measures of motivation (i.e., pre and post interviews, teacher ratings, and self-reports) to identify predictors of growth in reading comprehension over 4 months, in 31 4th grade student. Motivation emerged was a semi-independent construct. The interviews, teacher ratings, and self-reports were not highly related with one another. Also, motivations to read information books versus narrative books were not highly associated. Interviews of motivation were the best predictors and were positively associated with growth in reading comprehension (Guthrie, Hao, Wigfield, Tonks, Humericks, & Little, 2007). The greater motivation or interest children have in reading or learning a language the more linguistic input they experience and process (Tarone, 2007). Assessing motivation and interest in reading should account for individual variation in English L1 and L2 adolescent's reading skills.

Print Exposure

Print exposure is used as an approximation of the amount of text that an individual has processed. Print exposure attempts to measure the reading experience an individual has acquired outside the classroom. Someone high in print exposure had greater exposure to literature than someone low in print exposure. Stanovich, West and Harrison (1995) were interested in understanding the relationship between print exposure and knowledge. The authors tested a large sample of college students and older adults on two general knowledge tasks, a vocabulary task, a working memory task, a nonverbal reasoning test and lastly, several measures of print exposure. Their results showed that print exposure was a significant predictor of vocabulary and declarative knowledge suggesting that there is a strong role of exposure to print in the development of background knowledge. Print exposure accounted for individual variation in knowledge acquisition and maintenance. Stanovich et al.'s results demonstrate that an increase in print exposure expands an individual's mental lexicon, and strengthens his/her ability to read words and use of background knowledge to facilitate comprehension.

Cunningham and Stanovich (1997) conducted a longitudinal study on early reading acquisition and reading experience over a ten-year period (grade 1 through 11). They discovered that if the students got off to a fast start in reading they are more likely to engage in more reading, this finding is independent of their 11-th grade comprehension ability. The important finding in this study was that "individual differences in print exposure can predict the growth in reading comprehension ability throughout the elementary grades and thereafter" (Cunningham & Stanovich, 1997, 942).

The more exposure an individual has to print, the more their reading skills should develop, specifically vocabulary knowledge. Therefore it is important to examine if differential experience in print exposure is related to individual variation in adolescents' reading comprehension or vocabulary knowledge. Social factors influence the development of language and literacy through the quantity and quality of phonological or orthographic input a child receives. The greater the amount of input a child processes the more developed language and reading skills become (Cunningham & Stanovich, 1997; Tarone, 2007).

The Pilot Study

Pasquarella, Gottardo, and Grant (submitted) assessed reading comprehension performance, vocabulary knowledge, decoding ability and print exposure to authors and magazines in 31 English L1 and 49 English L2 adolescents (*M* age = 15.5 years). English L2 adolescents had lived in Canada for approximately 2.5 years and the common L1's of the students were Cantonese, Chinese, Spanish, Arabic, Farsi, and Bosnian. The results demonstrated large differences in all our measures between English L1 and L2 students. English L2 students were approximately two standard deviations below their peers on performance of all measures (except print exposure).

Factors related to reading comprehension were compared between English L1 and L2 students. Both groups produced a three-factor model. However, the factor loadings differed between groups. English L1 students had separate factors for (1) vocabulary knowledge, (2) phonological decoding, and (3) print exposure – a composite factor of exposure to authors and magazines. Whereas, the model for the English L2 students had three different factors: (1) vocabulary and phonological decoding, (2) exposure to magazines, and (3) exposure to authors. The results demonstrate that in early English L2 learners reading and oral language skills are represented as one factor. The findings from the pilot study and a review of past research has lead to the development of the specific research questions driving this proposal. A comprehensive examination of the reading skills of English L1 and L2 adolescents will provide clearer evidence towards an understanding of the intricate processes of reading comprehension in adolescent language learners.

Research Questions and Predictions

Can English L1 models of reading comprehension adequately explain English L2 reading comprehension performance? The following research questions have been proposed to examine what cognitive and social factors significantly contributed to reading comprehension in English L1 and L2 language learners. The final results are detailed models comparing English L1 and L2 reading comprehension noting differences and similarities.

1) Does the Simple View of Reading model (SVR; Gough & Tunmer, 1986) provide reasonable fit for explaining reading comprehension in English L1 and L2 adolescents?

Predictions:

Decoding. For English L1 students we predict that D will be significantly related to, and account for a small amount of unique variance in reading comprehension ability. The SVR (Gough & Tunmer, 1986; Hoover & Gough, 1990) demonstrated that as readers mature D becomes less predictive of individual variation in reading comprehension. There is less individual variation in D because mature readers are comfortable and knowledgeable about English phonology and orthography; which also explains why there would be little growth. Mature readers are less reliant on D because they have a well developed lexicon that can activate high frequency words automatically. However, D should still be significantly related to reading comprehension because in order to access meaning the reader must access the word. To illustrate this point Braze et al. (2005) found that decoding did explain individual differences in adolescent L1 speakers above and beyond the contributions of vocabulary and nonverbal reasoning.

For English L2 students we expect decoding to be significantly related to and a very strong predictor of reading comprehension. English L2 adolescents will not have a well developed lexicon, and most words will not be highly familiar and must be decoded.
There will be great variability between L2 individuals because English L2 adolescents are still learning English phonology and orthography.

Listening comprehension. We predict that listening comprehension, measured by vocabulary knowledge tasks, will be significantly related to, as well as a strong predictor of reading comprehension ability in English L1 and L2 adolescents. We also predict that the relationship will be stronger for English L1 than L2 adolescents because English L1 adolescents will have a more developed English oral comprehension skills which will greatly aid text comprehension.

2) Does the four component model (4C; Cain, Oakhill, & Bryant, 2005) provide better fit for explaining English L1 and L2 reading comprehension than the SVR?

Predictions:

We predict that the 4C model will provide a better fit for explaining English L1 and L2 reading comprehension than the SVR. However we expect slightly different models between samples. For English L1 students, working memory will be a marginal predictor of reading comprehension. Higher order comprehension skills should be a strong predictor of reading comprehension. For English L2 students, working memory will be a strong predictor of reading comprehension because English L2 students will need to spend more cognitive resources decoding words than English L1 students. Therefore, English L2 working memory capacity will be under greater stress and will be more likely to function under reduced efficiency during text reading. Working memory capacity will play a stronger role in determining individual differences in English L2 reading comprehension ability, as opposed to English L1 reading comprehension ability.

We predict that higher-order comprehension skills will be a significant predictor of reading for English L1 students but will not be as strong a predictor for English L2 students. Both English L1 and L2 students should be able to use comprehension strategies to comprehend text but we think that English L1 students will be more likely to engage in the use of these strategies because of extra cognitive resources available. English L2 students are going to have a greater cognitive load when reading English text. There may not be enough cognitive resources available for English L2 students to be able to integrate information or monitor comprehension effectively.

3) What are the roles of interest in reading (motivation) and print exposure in the reading skills of English L1 and L2 adolescents?

Predictions:

We predict that reading motivation and print exposure will contribute to a model of reading comprehension for English L1 and L2 students. We predict that motivation will be an important factor in explaining variance in reading comprehension of English L1 and L2 students. Students with higher motivation to read will also have higher reading comprehension scores, and relatively larger vocabularies. Print exposure is a construct that should be related to motivation to read, vocabulary knowledge, and reading comprehension. We predict that print exposure will emerge as an independent construct that contributes to reading comprehension. However, print exposure will share variance with motivation and vocabulary knowledge in relation to reading comprehension for both English L1 and L2 students.

METHOD

Participants

Recruitment occurred via two alternative methods: (1) teachers in English and English as Second Language (ESL) classrooms outlined the project and distributed consent forms to interested students; (2) the student researcher visited the schools at their lunch break to describe the project, and invite students to participate. Interested students provided an email address to find out more about the study and were given a link to sign up for the testing sessions on an online poll. Prior to the study the students signed consent forms and an additional copy was sent home for their parents/guardians to sign. In total 109 adolescents from three high schools – one in each of Waterloo, Kitchener, and Cambridge in Ontario - participated in this study.

Of the 109 students who participated, 55 spoke English as their first language. The English L1 group consisted of 30 males and 25 females with a mean age of 15.04 years (SD = 1.05). Twenty-three L1 students were from the Waterloo school, 6 from the Kitchener school and

23 from the Cambridge school. In total 54 English L2 students participated in the study. There were 31 male and 23 female L2 students with a mean age of 15.72 years (*SD* = 1.25). Twenty-nine L2 students were from the Waterloo school, 23 from the Kitchener school and 2 from the Cambridge school. The English L2 students, on average, have lived in Canada for 3.58 years (*SD* = 2.49 years: *Range* = 3 months – 8 years), and on average had moved to Canada when they were about 13 years old.

Participation from English L2 students was restricted by the amount of time they have lived in Canada. Time spent in Canada changes the "type", or definition, of the English language learner. Bilingualism, or language learning, can be defined according to several criteria. For instance individuals can be classified as *early* or *late* bilinguals. Early bilinguals acquire a second language in infancy or early childhood, whereas, late bilinguals acquire a second language in later childhood, adolescence or adulthood. Furthermore, there are *simultaneous bilinguals* who acquire two languages at the same time and *sequential bilinguals* who acquire a second language after the first language (Valdes & Figueroa, 1994). The English L2 adolescents in this study were late sequential bilinguals because their English abilities are dramatically changing and drastically different than English L1 peers. English L2 students are learning to read English at the word and text level, which is a critical time to address reading comprehension differences between English L1 and L2's and within English L2's. In order to ensure that English L2 participants are actually sequential bilinguals they must have lived in Canada for no longer than eight years to be included in the study. The eight-year bench mark for inclusion is theoretically relevant because Collier (1987) demonstrated that it takes L2 learners between six to eight years to become proficient speakers and readers of English. Therefore, we can reason that students who have been in Canada 8 years or less are representative of English L2 learners acquiring English and working towards grade-level reading. In fact, there were only six students who had been in Canada between 6-8 years. The analysis was also conducted without these students and the results remained the same. Therefore, in the final analysis the six students were kept in the analysis because they are not reading at grade-level and still representative of students acquiring basic English skills.

A total number of 14 different languages were represented in this heterogeneous sample of English L2 students. The languages were Chinese (N=19), Arabic (N=10), Spanish (N=5), Farsi/Persian (N=5), Japanese (N=4) and Romanian (N=3). Languages spoken by one participant were Creole, French, Jamaican, Nura, Somalian, Swahili, Tigrinya, and Turkish. The adolescents from all language groups demonstrated sufficient skill to complete all tasks. The adolescents lived in the same neighbourhoods and went to the same schools. The participant diversity reflects the multicultural nature of students in the Canadian educational system.

To examine if the broad membership of the English L2 group created a confound within the study, similarities and differences in mean scores and correlations were examined prior to the major analysis. English L2 students were collapsed into two categories based on L1 orthographic representation: (1) Logographic or (2) Alphabetic. [If more participants were available the congruency of orthographic depth between L1 and L2, and specific language groups (e.g., Cantonese, Mandarin, Arabic, Persian, Latin), would have been examined in conjunction with the congruency of orthographic representation].

The logographic group included 23 students who spoke Chinese (N = 19) or Japanese (N = 4), whereas, the alphabetic group included 31 students who spoke one of the remaining languages represented (Arabic, Spanish, Farsi/Persian, Romanian, Creole, French, Jamaican, Nura, Somalian, Swahili, Tigrinya, and Turkish). The two groups were constructed to confirm there are not significant differences between the group on the measures of reading, language and memory. The results of the L2 group comparisons are presented in Tables 1-3, and will be discussed in the results section.

Procedures

English L1 and L2 participants participated in two sessions of no longer than 2 hours each session. The participants were rewarded $20 for participation. The testing session was divided into two parts, a group section and an individual section. Within each testing session the individual and group sections were counterbalanced to eliminate effects due to testing order; half of the testing group completed the group section first while the other half completed the individual section first. The measures used are listed below:

The group section consists of the participants completing the Gates-MacGinitie Reading Test IV, a Vocabulary Recognition test, the Expressive One Word Picture Vocabulary Test, a Morphological Processing test, the Title Recognition Test for Teens, Interest in Reading Questionnaire (Reading Motivation), Language Use Questionnaire, Index of Reading Awareness (Comprehension Strategies), and the Matrix Analogies Test. The individual section consisted of the oral vocabulary, word reading and decoding, and the verbal working memory tasks. For the individual section each participant was paired with a trained research assistant who administered and later scored the tests.

Measures

Reading Comprehension

Form E of the Gates-MacGinitie Reading Test (GMRT) Second Canadian Edition was used as the measure of reading comprehension. Form E is appropriate for students who are reading from a 7^{th} grade to a 9^{th} grade level. The comprehension test is composed of short passages from published books and periodicals that reflect the type of materials that students typically read for school and recreation. In addition, the GMRT produces out of scale norms for students in grades 10 or higher. Students read 14 passages and answered 48 multiple choices questions. The total number of questions answered correctly determined a reading comprehension raw score. Raw scores were transformed into stanine scores and age equivalents. The Kurder-Richardson Formula 20 produced a reliability rating of .89.

Verbal Working Memory

The measure that assessed the capacity of working memory was an adaptation of a Daneman and Carpenter (1980) task (Gottardo, Stanovich & Siegel, 1996). The participants responded to orally administered sets of simple true/false statements (Cars have four wheels; Fish swim in the sky) that were presented via a pre-recorded audio file. Then the participants recalled the final word of each statement (wheels, sky), at the end of a set. There were 2 items sets, three 3 item sets, and four 4 item stimulus sets. Two scores were calculated: (1) an accuracy score, which is the number of correct true-or-false questions answered; and (2) a memory score, which is the number of final words remembered. The possible maximum accuracy and memory scores were 42. The split-half reliability of this task in the Gottardo et al. study was .80.

Decoding

The Test of Word Reading Efficiency (TOWRE) assessed the participant's word reading fluency in English. Also, participants were asked to read a list of pseudowords to assess phonetic decoding efficiency in English. Participants were scored on the length of time it took them to read the list and the number of words or pseudowords read correctly. The participants place in the list was marked at 45 second. The number of words and pseudowords read correctly in 45 seconds was transferred into standard scores. The TOWRE had a standardized mean average of

100 with a standard deviation of 15. The test-retest reliability for ages 10-18 years is .84 and .89 for the words and pseudowords tasks respectively (Trogesen, Wagner, & Rashotte, 1999).

The Woodcock Word Identification (Word Id) task assessed the participant's untimed word reading skills. The test was stopped when the students read 6 consecutive words incorrectly. The test consists of the participants reading a list of words that increase in length and difficulty. The Word Id task had an internal consistency reliability of .92. The Woodcock Word Attack task is a list of pseudowords. The Word Attack task assessed an individual's proficiency with English phonemes and phonological decoding. As a participant progresses through the list the pseudowords become longer and more difficult to pronounce. The task is stopped when 6 consecutive stimuli are read incorrectly. This task had an internal consistency of reliability of .91 (Woodcock, 1991). The raw scores for both lists consist of the number of words spoken correctly. Raw scores were transferred into standard scores.

Oral language proficiency

Vocabulary Knowledge

Measures of vocabulary breadth and depth that examine connections between semantics, phonological and orthographic representations were used to assess the quality of lexical representations. Five different measures are used to assess vocabulary knowledge and lexical quality; two were written and three were oral measures.

Written Measures.

The participants completed a Vocabulary Recognition task, an unpublished task developed by Dr. Penny Collins (see Appendix A), which acted as a measure of vocabulary breath. In this task, participants read a list of 80 words. Some of them are real words and some of them are foils. The participants were asked to check mark the words they know to be real. The proportion of correct words checked minus the proportion of foils checked produced raw scores.

A modified version of the Expressive One Word Picture Vocabulary Test (EOWPVT) was used as an additional measure of vocabulary breath. Usually the EOWPVT is an orally administered measure, where a student is shown a picture and has to produce one word to name the picture. In this study, the EOWPVT was modified to be administered within the group section. Item 30 to 170 were resized and 8 pictures were placed on a page. The students wrote one word to name or describe what is in the picture using one word only. For all students appropriate basal levels were established – the first six items were correctly identified. A ceiling score was established when students incorrectly identified six consecutive pictures. Responses that were incorrect received a score of 0, responses that were correctly identified but misspelled received a score of 1, whereas items correctly spelt received a score of 2. This coding scheme was used to create a measure of vocabulary breath that captures the student's orthographic knowledge. Since the methods of administration were changed standard scores could not be produced.

Oral Measures. The Peabody Picture Vocabulary Test III (PPVT-III; Dunn & Dunn, 1997) was administered as an additional measure of vocabulary knowledge breath. The participants look at four picture alternatives and pick the one picture that corresponds best to a word read aloud. The session was stopped when the participants incorrectly identified eight word-picture relations in one set. A raw score was obtained by taking the number of the last item coded and subtracting the number of incorrect answers given throughout the test. Raw scores were transformed to standard scores, age equivalency and percentile rankings for analysis. The PPVT-III has a standardized mean average of 100 with a standard deviation of 15.

A measure of depth of vocabulary knowledge used was the Woodcock Oral Vocabulary: Antonyms and Synonyms test. The participants heard a word orally and provided either a synonym or antonym as requested. The participants received one point for each synonym or antonym he or she can answer correctly. A total score was tabulated for the synonyms and antonyms separately and then the two scores were added together to form a raw score for the test. The raw scores were transferred into standard scores and age and grade equivalencies. This test had a standardized mean of 100 with a standard deviation of 15. The internal consistency reliability of this test is .85 and .90 for 13 and 18 year old people respectively (Woodcock, 1991).

Morphological Processing

The written tests of derivational and decomposition morphology were used to assess morphological processing (Carlisle, 2000). In the derivational test participants read a word paired with an incomplete sentence. The participants were to transform the word provided into a form that correctly completed the sentence (e.g., *teach.* He was a good ______ *teacher*). In the decomposition test participants were asked to do the same task except the words provided need to be deconstructed into the root form (e.g., *growth.* She wanted her plant to ______ *grow*). Raw scores were obtained from the number of correct sentences on both forms.

Comprehension Strategies

The Index of Reading Awareness (IRA; Jacobs & Paris, 1987) is a questionnaire that measures higher-level comprehension strategies. This 20 item multiple choice questionnaire has three alternative responses that represent an inappropriate response (0 points), a partially adequate response (1 point), and a strategic response (2 points). The questionnaire is divided into four sections that examine *evaluation of reading* (e.g., what is the hardest part about the story?) *planning in reading* (e.g., before you start to read, what kind of plans do you make to help you read better?) *regulation in reading* (e.g., what things do you read faster than others?) and *conditional knowledge in reading* (e.g., If you are reading a story for fun, what would you do?). The sections of this questionnaire measure meta-cognition about reading and different strategies used while reading. The 20 item IRA questionnaire obtained a general rating of higher order comprehension skills. Raw scores were tabulated by adding up the number of points obtain.

Nonverbal Reasoning (Matrix Analogies Reasoning)

Participants completed the Reasoning by Analogy and Spatial Visualization subtest of the Matrix Analogies Reasoning Test. Participants were required to pick the option that completed a picture or completed a set of items. As participants progressed through the sets, the mental reasoning or visualization needed to correctly complete the picture increased. Participants stop if they failed 4 consecutive items. Raw scores are calculated by the number of correct items from each subtest. The maximum score possible score is 32. This measure was mainly be used as a control variable because general cognitive ability is assumed to be related to reading comprehension and the other reading, language and memory skills under investigation.

Print Exposure

A measure of print exposure allowed us to determine the student's experience with out of school reading. The Title Recognition Test is a well-known, reliable and valid measure of print exposure (TRT: Cunningham & Stanovich, 1997). To create a test that is more appropriate to adolescent literature the Title Recognition Test for Teens (TRTT) has been developed. By perusing bestseller list and award winning books in teen genres 14 new targets and 13 new foils were added to the original TRT (see Appendix B). The students were asked to identify real titles in a list of 40 real titles and 30 foils. The proportion of real titles checked minus the proportion of foils checked produced raw scores.

Reading Motivation

The Intrinsic Interest in Reading questionnaire (Frijters, Barron, & Burnello, 2000) was used as the measure of reading motivation. Participants were asked to rate the extent to which they agree or disagree with a number of statements on a six point Likert scale. Higher scores reflected greater interest in reading. Questions referred to the enjoyment of reading (e.g., reading is fun to do), reading for pleasure (e.g., If I could choose what do to right now, I would read a book), persistence (e.g., Even when a book is hard to read, I stick with it), and personal perception of reading ability (e.g., I feel good about how well I can read) (see Appendix C). Responses were scored on a 6 point scale from 1 to 6 – strong disagreement gets a score of 1 where strong agreement gets a score of 6. The maximum score on the scale is 120. The total score participants obtain on this questionnaire produced their raw score.

Language Use Questionnaire

The Language Use Questionnaire was used to collect descriptive information on the participant's current grade, how long they have lived in Canada, and what age/grade they were in when they first immigrated to Canada. The questionnaire was designed to measure how often the participants speak English with their family and friends, as well as how often they read English print and watch television in English. Five questions, scored on a 5 point Likert-type scale (never-rarely-sometimes-often-frequently), were used to measure how often participants spoke English with their grandparents, parents, siblings and friends at school and outside of school. Using the same Likert scale, the participants rated how often they watch television in English and in their native language. Also, the participants rated how often they read (outside of school) in both their native language and in English. Finally, the participants rated how many books they have in their native language and in English (none, 1-5, 6-10, 10-25, more that 25) (see Appendix D).

Results

Before comparisons between English L1 and L2 students could be made, the similarities and differences of subgroups within the English L2 sample were examined to confirm that native language was not acting as a confound. Once adequate homogeneity of the English L2 groups was established the subgroups were collapsed and measures for English L1 and English L2 adolescents were compared using one-way ANOVA tests. Next, a correlation matrix for all measures was calculated separately for English L1 and L2 adolescents. Then, data reduction was accomplished using factor analysis. The resulting factors were used in hierarchical regression analyses to determine factors uniquely related to reading comprehension in each group. Tests of indirect effects and comparisons between the base model and the expanded model conclude this section.

L2 Subgroup Comparisons: Alphabetic vs. Logographic First Language Speakers

Means, standard deviations, and F-tests for the raw and standardized scores of all measures are displayed in Table 1 for English L2 adolescents from alphabetic and logographic L1 groups. A Brown-Forsyth F-test correction was used when the assumption of homogeneity was violated. Overall, F-tests revealed that the groups did not significantly differ in terms of scores obtained on most measures. Only the measures of nonverbal reasoning (NV), reading comprehension (RC) and the comprehension strategies (CS) were significantly different, with the Logographic group obtaining higher scores than the Alphabetic group. There was a great difference ($p < .001$) between groups on the NV task, and a marginally significant difference for RC and CS ($p = .035$, $p = .020$, respectively). It is possible that the significant group differences on the reading comprehension and comprehension strategies task may not survive after controlling for the nonverbal reasoning task. To test this hypothesis, the reading comprehension and comprehension strategies variables were entered as the dependent or criterion variable in different Univarite ANOVA's; nonverbal reasoning was entered as a covariate and a Home Script (Alphabetic or Logographic) Dummy Variable (DV) was entered as a fixed independent variable. After controlling for nonverbal ability, no differences were found between groups on measures of reading comprehension [Home Script DV $F(1, 51) = 1.99$, $p = .165$] and comprehension strategies, $F(1, 51) = .30$, $p = .59$. So far we can conclude that the Alphabetic and Logographic groups had reading, language, memory and experience scores are similar, with the exception of scores on the nonverbal reasoning measure.

A correlation matrix of all the variables is presented in Table 2, with the Alphabetic group above the diagonal and the Logographic group below the diagonal. Overall, the correlation matrices produced for the Alphabetic and Logographic subgroups are very similar. Measures of similar constructs are highly correlated with each other. For both groups, reading comprehension shares moderate to strong correlations with vocabulary knowledge. Decoding is also significantly related to reading comprehension for both groups; however, correlations between measures of pseudoword decoding and comprehension are non-significant in the logographic group. For the logographic group the nonverbal task is not significantly related to anything, but for the alphabetic group the MAT is highly correlated with the comprehension and vocabulary measures. The non-significant correlation of MAT with the other measures for the logographic group is most likely due to a ceiling effect and low variability in scores produced, and a distribution negatively skewed (left). The logographic group mean was 28 out of a possible 32 with a SD of 2.77; this group may have shown ceiling effects on the measure. Another notable difference is the correlation between reading comprehension and the comprehension strategies; this measure is highly correlated for the alphabetic group but not the logographic group. So far, there are some slight differences between groups in the strength and significance of the correlations produced, but the similarities outweigh the differences.

As a final examination of group homogeneity, Home Script (alphabetic or logographic) was coded as a dummy variable and entered into a hierarchical regression predicting reading comprehension (see Table 3). When the Home Script variable was entered into the first step of a hierarchical regression it was a significant predictor of reading comprehension and explained 8% of the variance in comprehension scores. However, as the other variables were entered (e.g., decoding, vocabulary knowledge, etc.) the influence of Home Script in the model became nonsignificant. In the final model Home Script was not a unique statistical predictor of reading comprehension.

Overall, the similarities of the relationships among variables for the Logographic and Alphabetic subgroups outweigh the differences. In terms of examining English reading and language variables only, we can consider the Logographic and Alphabetic groups highly similar. Therefore we have statistical support that aggregating the two groups to form an English L2 group that does not produce a confound in terms of heterogeneity within the English L2 group, when examining the influence of English reading, language, memory and experience variables on English reading comprehension.

English L1 and L2 Group Differences

Means, standard deviations, and F-tests for the raw and standardized scores of all measures are displayed in Table 4 for English L1 and L2 adolescents. The *F*-tests reported have the corrected degrees of freedom needed for analyses when the assumption of equal variances was not met. English L1 adolescents performed better on all reading and vocabulary tasks in comparison to English L2 adolescents, as well as print exposure and reading motivation tasks. No differences were found on the comprehension strategies, working memory and the nonverbal reasoning measures. It was expected that English L1 adolescents would outperform English L2 adolescents on reading and vocabulary measures. However, the degree of difference between the groups on reading and vocabulary skills was much larger than expected.

It is important to note that the English L1 adolescents scored within the average range on measures of comprehension, vocabulary and decoding with most scores close to the standardized mean. The English L1 student's reading skills are at the appropriate grade level for measures of reading comprehension, vocabulary knowledge, and word reading. Comparatively, the English L2 students had mean standard scores between 1 and 2 standard deviations below the standardized norms on all reading measures (please see Table 4 for specific values and significance tests).

Grade and age equivalent scores were calculated for English L1 and L2 adolescents to illustrate the challenges that English L2 adolescents are likely to face in completing the high school curriculum. In terms of grade equivalent scores, English L1 adolescent's Gates MacGinitie Reading Comprehension Grade Equivalence score (GE) was 7.73 (SD = 3.26), whereas the English L2 adolescents GE was 5.34 (SD = 3.17). For the WRMT-R Word Identification and Word Attack scores, English L1 students had GE's of 10.92 (SD = 4.04) and 11.17 (SD = 5.29) respectively, and English L2 students had GE's of 8.18 (SD = 6.57) and 7.34 (SD = 5.87) respectively. For measures of vocabulary, English L1 and L2 students respective GE's for the WLPB-R Oral Vocabulary was 10.18 (SD = 4.13) and 4.86 (SD = 3.88). Only age equivalent scores (AE) are available for the PPVT-III. English L1 and L2 adolescents had respective AE's of 16.30 (SD = 4.65) and 9.91 (SD = 5.32). The equivalent scores demonstrate that English L1 students are achieving within the normal range on measures of vocabulary knowledge and decoding; however, English L1 students reading comprehension average is slightly below grade level. Comparatively, English L2 students reading skills were considerably lower than their English L1 peers; especially for measures of vocabulary knowledge and reading comprehension. The English L2 student's vocabulary skills are substantially lower than required for successful comprehension of grade-level reading.

Intercorrelations among primary variables

Table 5 displays two correlation matrices for all of the variables, with the English L1 matrix presented above the diagonal and the English L2 matrix presented below the diagonal. Mostly similarities but some differences are noted between groups. In both groups, reading comprehension was significantly correlated with all variables, with the exception of the Title Recognition Task for Teens (TRTT) which was not correlated with anything in the English L2 group. For the English L2 group the TRTT had scores at chance and very little variability. The English L2 students had floor effects on this measure because of their limited exposure to English print. Correlations among variables across constructs were moderate in strength for English L1 and moderate to strong for English L2 adolescents. Secondly, correlations within constructs (e.g., decoding, vocabulary knowledge, working memory) were generally moderate to strong for both groups.

Factorial Analysis

A series of exploratory factor analyses were used to reduce the data and create constructs for use in the regression analyses. The exploratory factor analyses were conducted on measures of vocabulary knowledge (Vocabulary Recognition, Morphological Awareness, EOWPVT, PPVT, WLPB-R Oral Vocabulary), decoding (TOWRE words and nonwords, Word Identification, Word Attack) and working memory (Working Memory Word Recall, Working Memory True-False Judgment). Only these cognitive measures were examined in the factor analysis because we wanted to look at comprehension strategies, reading motivation (intrinsic interest in reading), and exposure to print as unique components. Factor analyses were conducted separately for English L1 and L2 groups to determine factor loadings for measures related to reading comprehension. Factors with rotated eigenvalues greater than 1 were extracted; according to the criterion of acceptance and examination of the Scree-plot, a two-factor model for English L2 sample (see Table 6) and a three-factor model was supported for the English L1 sample (see Table 7). We used a varimax rotation (an orthogonal solution) and considered factor loadings greater than .50 to be meaningful. The English L1 sample had rotated eigenvalues for Factors 1 to 3 of 5.99, 1.59 and 1.0 respectively, which explained 78.19% of the variance. The English L2 sample had rotated eigenvalues for Factors 1 and 2 of 7.26 and 1.38 respectively, which explained 78.58% of the variance.

For English L1 students, the exploratory factor analysis yielded a three factor model where Factor 1 was interpreted to represent *vocabulary knowledge* because all measures of vocabulary knowledge and morphology loaded onto this factor. Factor 2 was interpreted to represent *decoding* because all the measures of decoding loaded onto this factor. Interestingly, morphology loaded equally onto the vocabulary knowledge and decoding factors, and appeared to be related to both factors. Finally, Factor 3 was interpreted to represent *working memory* because the two measures of working memory loaded onto this factor. As these results are consistent with previous research and with models of reading, these factors were used in further analyses.

For English L2 students, the exploratory factor analysis yielded two factors. Factor 1 was interpreted to represent a *vocabulary and decoding* factor because the vocabulary and morphology measures expect Vocabulary Recognition loaded onto this factor. Factor 2 was interpreted to represent a *vocabulary and working memory* factor because the measures of vocabulary knowledge, morphology and working memory loaded onto this factor. In this factor analysis the measures of vocabulary and morphology loaded equally onto both factors (see Table 6).

In order to compare models of reading in L1 and L2 speakers, a confirmatory factor analysis was conducted. The second factor analysis was conducted to examine if vocabulary knowledge could be separated as a factor unique from decoding. This analysis would allow us to examine the unique contributions of vocabulary knowledge and decoding on reading comprehension and makes comparisons between the English L1 and L2 groups more transparent. The confirmatory factor analysis forced the data into three factors for English L2 adolescents. In this analysis (see Table 7) the English L2 sample had rotated eigenvalues for Factors 1 to 3 of 6.65, 1.37, and .74 respectively, which explained 87.50% of the variance. The confirmatory factor model was successful in separating vocabulary knowledge out as a unique factor. Factor 1 was interpreted to represent *vocabulary knowledge* because all measures of vocabulary knowledge and morphology loaded onto this factor. Factor 2 was interpreted to represent *decoding* because all the measures of decoding loaded onto this factor. Finally, factor 3 was interpreted to represent *working memory* because the two measures of working memory loaded onto this factor.

Hierarchical Regression Analysis: Factors directly and indirectly related to reading comprehension

Hierarchical regressions were run separately for English L1 (see Table 8) and L2 students (see Table 9). Hierarchical regression analyses were performed to examine the unique contributions of each construct in explaining variability in reading comprehension performance. For both groups the Gates MacGinitie Reading Comprehension raw scores were used as the criterion variable. (1) Nonverbal reasoning (Matrix Analogies Reasoning) (2) decoding, (3) vocabulary knowledge (4) working memory (from the previous factor analyses) (5) comprehension strategies (6) Interest and Exposure factors were entered as independent variables in the order listed for the initial ordering. The Interest and Exposure Factor was an aggregate variable create by Z scoring the Intrinsic Interest in Reading questionnaire and the Title Recognition Task for Teens, and then averaging the two Z scores into a composite score. The order of the variables was also entered in a reversed order[1] to determine if the constructs contribute unique or shared variance to reading comprehension. Considering the relatively modest sample size there is a limit to the number of variables that could be entered into the regression without jeopardizing the validity and power of the model. As a rule of thumb, for each 10 students sampled one independent variable can be added to the model. In terms of this project, there are 55 and 54 students in each group and in the models we used a maximum of 6 variables. All the components we added are meaningful and theoretically relevant so we did not want to leave out a component because of a few students in each group. The models did fit well and the assumptions of normality, homogeneity, and independence were met for all regressions.

For English L1 students, the model was significant in the final step, F (6, 48) = 18.68, $p < .001$, $R^2 = .70$ (see Table 8). In the final model, vocabulary knowledge ($\Delta R^2 = .34$, $\beta = .55$, $p < .001$), working memory ($\Delta R^2 = .04$, $\beta = .17$, $p < .05$) and comprehension strategies ($\Delta R^2 = .03$, β

[1] Reverse ordering of independent variables: (1) Interest and Exposure factor, (2) Index of Reading Awareness, (3) Working Memory, (4) vocabulary knowledge, (5) decoding, (6) nonverbal reasoning

= .21, $p < .05$), were significantly related to reading comprehension scores. Nonverbal reasoning, decoding and motivation and print exposure were not significant factors in the model. Initially nonverbal reasoning had a significant relationship with comprehension ($\beta = .53$, $p < .001$), explaining 28% of the variance. However, the strength and significance of the relationship changed as other variables were entered. Entering vocabulary knowledge into the regression changes the relationship between nonverbal reasoning and comprehension, by decreasing its beta weight by half its original strength. When the comprehension strategies task was entered into the second step of the regression, nonverbal reasoning was no longer significant. The results suggest that vocabulary knowledge is the largest contributor to reading comprehension, followed by working memory and comprehension strategies. Nonverbal reasoning does play a role in reading comprehension, however, its role is no longer significant when accounting for vocabulary knowledge and comprehension strategies.

When the variables were entered into the reverse order a similar story emerges, with one twist. The final model is the same, but when the motivation and print exposure factor was entered into the first step it was highly significant, ($\beta = .57$, $p < .001$). The relationship between comprehension and exposure became nonsignificant ($\beta = .17$) when vocabulary knowledge was entered into the regression. In fact, multiple regressions and a bootstrapping test of indirect effects (Baron & Kenny, 1986; Preacher & Hayes, 2004) confirm that relationships between print exposure and reading comprehension, and relationship between motivation and reading comprehension, is significantly mediated by vocabulary knowledge (see Figures 2 & 3 respectively). Even though in the final step measures of print exposure and interest in reading did not explain unique variance in reading comprehension, these measures are still important in understanding reading because the measures help explain individual variations in vocabulary knowledge and reading comprehension.

A mediator is defined as a third variable that accounts for the relationship between a predictor or independent variable and a dependent, outcome or criterion variable. A mediator is different than a moderator, the two terms are not meant to be used interchangeably. A moderating variable is generally a qualitative or categorical variable that changes the direction or strength of the relationship between an independent and dependent variable. The independent variable is partitioned into subgroups "that establish its maximum effectiveness" with reference to a dependent variable (Baron & Kenny, 1986, pp. 1173).

For a variable to function as a mediator the following conditions must be met:

1) The regression path *a* in Figure 1. should be significant. Variations in the independent variable (IV) should account for variations in the Mediator (M).
2) Path *b* should be significant. Variations in the M should account for variations in the DV.
3) When *a* and *b* are controlled, the previous relationships between the IV and DV (path *c'*) should become non-significant or reduce the strength of the association considerably (path c). Although Barron and Kenny (1986) say the IV should be correlated with the DV before a model of mediation is created, Shrout and Bolger (2002) disagree and state that a significant relation between the IV and DV "should not be a requirement when there is a priori belief that the effect is small or suppression is a possibility" (pp. 422).
4) A bootstrapping test was used to evaluate if the mediation model is significant. A bootstrapping test is the best option because it does not impose the assumption of a normal distribution and can be used when sample sizes are modest. Also this method produces a significance test of the indirect effect of the IV on the DV (Preacher & Hayes, 2004).

Throughout all of the regression analyses decoding did not emerge as a significant predictor of reading comprehension in English L1 adolescents, even though it is significantly correlated with reading comprehension. It is possible that decoding could have an indirect influence on comprehension through a mediating variable. It is theoretically reasonable to postulate that comprehension strategies may mediate or moderate the influence of decoding on comprehension. Good use of comprehension strategies may help weak decoding. Alternatively, efficient decoding requires few cognitive resources, allowing other resources to be directed towards comprehension strategies. The result from the bootstrapping test of indirect effect confirmed that comprehension strategies significantly mediated the influence of decoding on reading comprehension (see Figure 4).

Indirect relationships of variables with reading comprehension for the English L2 group

For English L2 students, the model explaining reading comprehension performance was significant in the final step, F (6, 46) = 34.50, $p < .001$, $R^2 = .82$. In the final model, decoding ($\Delta R^2 = .06$, $\beta = .26$, $p < .001$), vocabulary knowledge ($\Delta R^2 = .24$, $\beta = .59$, $p < .001$) and working memory ($\Delta R^2 = .18$, $\beta = .45$, $p < .001$) were the significantly related to reading comprehension. Similar to the L1 results, initially nonverbal reasoning had a highly significant relationship with comprehension ($\beta = .59$, $p < .001$), explaining 34% of the variance. However, its relationship to reading comprehension became non-significant when working memory and comprehension strategies were entered. In the case of English L2 students, the results suggest that vocabulary knowledge is the largest contributor to reading comprehension, followed by working memory and decoding. Nonverbal reasoning does play a role in reading comprehension, however, the role becomes nonsignificant when accounting for working memory and comprehension strategies.

When the reverse order of variables was entered for the English L2 students, reading motivation was significantly related to reading comprehension performance ($\beta = .36, p < .01$). However, after entering comprehension strategies into the regression equation reading motivation became nonsignificant ($\beta = .13$). The significant relationship between comprehension strategies and reading comprehension ($\beta = .463, p < .001$) became nonsignificant when decoding was entered into the regression. When accounting for variability in decoding ability, the comprehension strategies factor was not significantly related to reading comprehension ($\beta = .16$). A bootstrapping test confirmed that the influence of reading motivation on reading comprehension was significantly mediated by the comprehension strategies measure (see Figure 5). To compare with the L1 mediation of decoding through comprehension strategies, a bootstrapping test confirmed that there was significant mediation of decoding through comprehension strategies in English L2 students reading comprehension (see Figure 6).

Testing fit: Does the 4C model significantly add to the SVR model?

In order to evaluate hypothesis 1 and 2 a test was conducted to determine if adding working memory (WM) and comprehension strategies (CS) improved the base model of nonverbal reasoning (NV), decoding (D) and vocabulary knowledge (V) when explaining variance in reading comprehension (RC). Therefore a base model (RC = NV + D + V) was compared to an expanded model (RC = NV + D + V + WM + CS) that has the base model nested within it. An online statistical calculator was used to find the F-value associated with the addition of components to the base model in hierarchical regressions (Soper, 2009). For English L1 students, the addition of the WM and CS components significantly improved the model, $F(4, 50) = 3.52, p < .05$, a critical F value associated with the degrees of freedom was 2.55. A similar story emerged for English L2 students; the addition of the WM and CS components significantly improved the model, $F(4, 49) = 20.59, p < .001$. In both groups the addition of the WM and CS factors significantly improves the model. When examining reading comprehension in diverse groups of adolescent L1 and L2 learners an expanded model that combines multiple cognitive, memory and language components should be employed.

Discussion

The purpose of this project was to examine the relationships among reading comprehension, decoding, vocabulary knowledge, working memory, comprehension strategies, reading motivation and exposure to print in adolescents learning English as a L2 who recently immigrated to Canada, and a group of native English speaking adolescents. Conducting scientific research on the reading performance of this group reduces the gap in the literature regarding L2 learners because, to date, little research has examined reading in adolescent L2 learners (August & Shanahan, 2006; Kirby & Savage, 2008). The first objective was to assess the reading performance of native English speakers, and adolescents with diverse cultural backgrounds who were learning English as a second language. The final objectives were to examine similarities and differences between the group's models of reading comprehension and to describe what components are vital to our understanding of reading comprehension ability.

English L1 and L2 Performance Comparison

Overall, the English L1 students showed higher performance than the English L2 students on measures of reading comprehension, vocabulary knowledge, decoding, print exposure and reading motivation. On average, English L2 student's scores were between one and two standard deviations below their English L1 peers. English L2 adolescents reading comprehension and vocabulary are at the 5^{th} grade level and decoding is at the 7^{th} grade levels respectively. Only five English L2 students were reading at-grade level, approximately 90% of the sample was reading well below grade level. In order for most of the L2 students to catch up to peers by the end of high school, they will need to make about two years of growth on reading and language per year of schooling – without gold standard instruction that much growth will be extremely difficult to achieve and maintain. Differences between English L1 and L2 student's scores were not found on measures of comprehension strategies, working memory and nonverbal reasoning; indicating that these groups differ in terms of proficiency with English, and are equivalent in terms of general processing and cognitive ability as measured by performance on memory and nonverbal reasoning tests.

Considering the English L2 adolescents' low level of proficiency in decoding, vocabulary knowledge and comprehension, many L2 adolescents are likely to struggle with high school curriculum and the completion of requirements necessary to graduate high school (EQAO 2008; Hoffman & Sable, 2006). This sample of English L2 adolescents does not have adequate literacy skills to comprehend grade level text and therefore to be able to "read to learn" from grade level text (Chall, 1983). The findings of this study are congruent with the body of literature stating that English L2 learners, especially adolescents, have difficulty achieving at grade level on written tests (Collier, 1987; Cummins, 1997; EQAO, 2008; Hoffman & Sable, 2006). The existing literature identifies adolescent L2 learners as being at-risk for problems with reading, and in need of instructional support to increase reading related skills, specifically vocabulary, content knowledge and fluency (Arts & Verhoeven, 1999; August & Shanahan, 2006; Droop & Verhoeven, 1998; EQAO, 2008; Hoffman & Sable, 2006; Verhoeven, 1990, 2000).

Factors related to reading comprehension

The results from this study demonstrate that the interrelations among vocabulary, memory, decoding, comprehension strategies and their contribution to comprehension for English L1 and L2 adolescents are somewhat different. For both groups all measures were positively related to reading comprehension (except a non-significant relation between print exposure and reading comprehension for English L2 students). However, the relationships among variables were stronger for English L2 than L1 students. Furthermore, exploratory factor analyses of vocabulary decoding and working memory produced different factors for each group. For English L1 students, a three factor model of (1) written and oral vocabulary (2) decoding and (3) working memory emerged. Since multiple measures of vocabulary knowledge were loaded onto an unitary factors we can interpret written and oral vocabulary knowledge to be synonymous with lexical quality (Perfetti & Hart, 2001; Perfetti, 2007). A representation of high lexical quality will have a fully specified spelling (orthography), a familiar phonological representation, and is linked to a semantic network. Within our study we examined the depth and breadth of vocabulary knowledge in terms of the connections between semantic, phonological and orthographic representations. Therefore we have a factor of vocabulary knowledge that reports the quality of lexical representations not just the amount of word knowledge. Having a comprehensive assessment of vocabulary knowledge is critically important for understanding its relationship with reading comprehension as previous research has shown reading to be related to both the breadth and depth of vocabulary knowledge (Perfetti, 2007, Protopapas et al., 2007, Tannenbaum, Torgesen, & Wagner, 2006).

Another point worth noting is that morphological awareness loaded virtually equally onto the vocabulary and decoding factors, with a slightly higher loading on decoding for English L1 adolescents. The results suggest that morphological awareness is strongly related to both factors. It is plausible that morphological awareness acts as a link between vocabulary knowledge and decoding because flexibility with morphological derivations requires root word identification and vocabulary knowledge of the root word and its possible forms. Further investigation is warranted to explore this proposition. More measures of morphological awareness, including measures of compound words and prefix usage, and the use of morphemes to create pseudowords could be used to examine how the subcomponents of morphological awareness are uniquely related to decoding and vocabulary knowledge in adolescent and adult native speakers.

For English L2 students, the exploratory factor analysis yielded a two factor model of (1) vocabulary and decoding, and (2) vocabulary and working memory. The results indicate that there is considerable overlap and highly significant relationships between measures of decoding and working memory with vocabulary knowledge. Both measures of oral and written vocabulary load onto each factor making the mode of the task (method variance) an unlikely culprit. Decoding and working memory appear to be two distinct factors because the measures loaded heavily onto only one factor. The results are very similar to the pilot study conducted by Pasquarella, Gottardo and Grant (submitted). In the exploratory analysis for the English L2 group in the pilot study, vocabulary knowledge and decoding loaded onto a single factor. In both samples of adolescent English L2 learners, vocabulary knowledge and decoding are highly related constructs. It is possible that vocabulary knowledge has not developed enough to separate as a unique construct and that L2 general language ability is a unitary construct in beginners. The same patterns are not found in research on younger bilingual children; vocabulary knowledge is separate from decoding (Gottardo, 2002). Over time and development vocabulary knowledge should emerge as a unique factor. However, in order to compare models of reading comprehension a confirmatory factor analysis was conducted, forcing three factors. We can see through the confirmatory factor analysis that when we force the measures into three factors, (1) vocabulary knowledge, (2) decoding and (3) working memory emerge as separate factors. We believe this demonstrates that English vocabulary knowledge had the potential to separate itself out as a unique factor, however until further research is conducted we can only speculate as to why decoding and vocabulary knowledge are intertwined in English L2 adolescents. Since we were able to get equivalent factors for English L1 and L2 students, the comparison of models of reading comprehension between groups is very transparent.

Comparing simple and multi-component models: What factors are important?

The major objective of this project (hypotheses 1 and 2) was to examine and explain reading comprehension performance for English L1 and L2 adolescents. Furthermore, we set out to evaluate the utility of models developed on English L1 children and adolescents to explain reading comprehension in English L2 adolescents. We evaluated two theoretical models of reading comprehension, the Simple View of Reading (Gough & Tunmer, 1986)– which equated comprehension to equal the product of decoding and linguistic comprehension, and the 4C model (Cain et al., 2005) – which added working memory and comprehension strategies as unique and independent contributors to reading comprehension. To extend the work of our colleagues we also examined if reading motivation and print exposure (an aggregate variable) added any unique predictions. We also used a measure of nonverbal reasoning as a control variable within the model because of its significant relationship with reading comprehension and the other constructs under investigation.

For English L1 students, vocabulary knowledge, working memory and comprehension strategies were significantly related to reading comprehension performance. Seventy percent of the variability in reading comprehension performance was captured by the six factor model (i.e., 4C model + non-verbal intelligence + motivation and exposure). Vocabulary knowledge shared the strongest relationship with reading comprehension after nonverbal reasoning was controlled. Working memory and comprehension strategies were significantly related to reading comprehension performance but the relationship was much weaker than the reading comprehension-vocabulary knowledge relationship. In the final six factor model decoding, motivation and print exposure, and nonverbal reasoning were not significantly related to reading comprehension performance. The initial ordering of the six factor model demonstrates that vocabulary knowledge, working memory, and comprehension strategies explain substantial variability in reading performance. Therefore, the six factor model does a better job at explaining individual variability in reading comprehension performance, when compared to the SVR model.

When motivation and print exposure are entered into the model before vocabulary knowledge the constructs (motivation and print exposure) are significantly related to reading comprehension performance. However, once vocabulary knowledge is entered into the model the relationship between reading comprehension and motivation and print exposure becomes non-significant. Testing a mediation model revealed that the relation between motivation, print exposure and reading comprehension was completely mediated by vocabulary knowledge. In other words, motivation and print exposure had an indirect effect on reading comprehension through vocabulary knowledge. Increased interest in reading and increased print exposure creates more experiences for an individual to learn new words and to strengthen lexical connections and familiarity of known words. The added exposure and experience helps develop vocabulary knowledge which can be used to comprehend advanced text (Stanovich, West, & Harrision, 1995; Perfetti, 2007; Verhooeven, 2000).

Even though the literature states that over time decoding becomes less predictive of reading comprehension performance (Catts et al., 2005), we are somewhat surprised that it did not emerge as a significant predictor of reading comprehension, especially because it is significantly correlated with reading comprehension. However, we did find that decoding has an indirect effect on reading comprehension. The relationship of decoding on reading comprehension is mediated by comprehension strategies. It is plausible that good use of comprehension strategies may compensate for weak decoding. For an alternative explanation, good decoding required fewer cognitive resources (Baddeley, 1983; Daneman & Carpenter, 1980), allowing more resources to be used to implement comprehension strategies. As children mature, individual differences in decoding ability lessen and the ability to use comprehension strategies to read advanced text may be a more useful construct in understanding individual differences in reading comprehension performance. At this point, we can only be speculative about the relationship between decoding, comprehension strategies, and reading comprehension. Further investigation is needed to understand if comprehension strategy use is a general or task-specific construct, and if different comprehension strategies are differentially related to reading comprehension and decoding.

Overall for English L1 students, a multi-component model of reading comprehension that combines measures of decoding, vocabulary knowledge, working memory and comprehension strategies does a significantly better job at explaining individual variation in reading comprehension than a model that measures decoding and vocabulary knowledge only. Furthermore, motivation and print exposure are important constructs to consider because of the indirect relationship they share with reading comprehension. Also motivation and print exposure variables are important in understanding differences in vocabulary knowledge and provide insight into instructional techniques that could be used to increase vocabulary.

For English L2 students, decoding, vocabulary knowledge and working memory were significantly related to reading comprehension performance. Eighty-two percent of the variability in reading comprehension performance was captured by the model. Vocabulary knowledge shared the strongest relationship with reading comprehension performance after controlling for nonverbal reasoning. Working memory also shared a strong relationship with reading comprehension. Decoding was also significantly related to reading comprehension. In the final model, nonverbal reasoning, comprehension strategies and reading motivation were not significantly related to reading comprehension.

For the English L2 students, the influence of reading motivation on reading comprehension was significantly mediated by comprehension strategies. This finding is different than the mediation model found with English L1 students – in the English L1 group vocabulary knowledge was mediating the effect of motivation on reading comprehension. For the English L2 students it is plausible that a mediation of motivation on comprehension strategies would show up before a mediation of interest on vocabulary. First, vocabulary is underdeveloped in this sample, whereas comprehension strategies were comparable to the English L1 students. The English L2 students with greater motivation had more opportunities to develop and use comprehension strategies in their first language than students with less interest in reading. Alternatively, students with some comprehension strategy use might feel better about reading English than students with little or no comprehension strategy use. Comprehension strategies should transfer easily between languages because the strategies are meta-cognitive in nature and reflect higher order thinking strategies as opposed to language specific or culturally relevant knowledge (Durgunoglu, 2002; van Gelderen, et al., 2007). Secondly, vocabulary knowledge is underdeveloped and the measure of print exposure indicates that the English L2 students have very little exposure to English print. Therefore, it is possible that the effects of motivation on reading comprehension will be mediated by vocabulary once exposure to English increases and the students have opportunities to increase their English lexicon.

As we just discussed comprehension strategies were significant when entered after reading motivation. However comprehension strategies became a non-significant predictor of reading comprehension performance when decoding was entered into the regression. A test of indirect effects confirmed that decoding shared partial mediation with comprehension strategies on reading comprehension, a finding similar to the English L1 students. However it seems counter intuitive that comprehension strategies mediated the relationships between decoding and reading comprehension because comprehension strategies is non-significant in the final model. Comprehension strategies are a higher-order component, whereas decoding is a lower-order component. In this case, we believe it is more probable for mediation to occur in a top-down process, where the higher order component is facilitating the lower-order component, because the comprehension strategies are reflexive and able to assist reading comprehension in a number of ways. Comprehension strategies can be used to facilitate word identification when decoding skills are weak by making the reader aware of the words they do not know or using contextual cues to help identify the meaning of unknown words. Alternatively if decoding skills are strong, comprehension strategies will be employed to grapple with text level comprehension and the integration of multiple sentence and paragraphs. We see that comprehension strategies have a direct influence of reading comprehension in the English L1 model and have an indirect influence on comprehension in the English L2 model. We propose that it is possible for comprehension strategies to facilitate comprehension by acting as a mediator of weak low-level skills or by the use of higher order comprehension strategies when low level skills are in place. When decoding skills are weak, comprehension strategies will be used at the word level, but if decoding is proficient, then comprehension strategies will be used at a higher level. Further research is needed to test the idea that comprehension skills are able to adapt to the reader's skills or lack of skills.

For English L2 students, a multi-component model of reading comprehension that combines measures of decoding, vocabulary knowledge, working memory and comprehension strategies does a significantly better job at explaining individual variation in reading comprehension than a model that measures decoding and vocabulary knowledge only. Furthermore for both groups, reading motivation and print exposure are important constructs to consider because of the indirect relationship they share with reading comprehension.

Overall for both groups, the multi-component model did an excellent job at explaining individual differences in reading comprehension performance. In this study, 70% and 82% of the variability was captured by the model for English L1 and L2 students, respectively. The amount of variance captured by our model is very high and similar to other studies on reading comprehension in adolescent populations. The Braze and colleagues (2007) expanded model of reading comprehension explained 82% of the variability, and the van Geldren and colleagues (2004) model explained 74% of L1 (Dutch) reading comprehension variability and 83% of L2 (English) reading comprehension variability. However, our model of reading comprehension did a much better job at explaining variations in reading comprehension compared to models of comprehension tested with children. For example, Protopapas et al. (2007) model of reading comprehension captured 38% of the variability in grade 2 and 48% of the variability in grade 4.

For both groups, vocabulary knowledge emerged as the component most strongly related to reading comprehension performance in adolescents. Working memory was also a significant predictor of reading comprehension performance for both groups, however, the relationship between reading comprehension and working memory was much stronger for English L2 than L1 students. English L2 students' word identification was not as automatic as English L1 students, as a result more cognitive resources needed to be directed towards working memory for activating words in the lexicon, and keeping words in mind long enough to comprehend the meaning of sentences, and trying to learn and retain new words encountered in text. It is possible that as English L2 student's word identification and vocabulary knowledge develops, the relationship between working memory and reading comprehension will decrease.

For English L2 students decoding was significantly related to reading comprehension ability, whereas it was not significantly related to reading comprehension for the English L1 students. Previous research indicates that decoding acts as a strong predictor of reading ability early in the language learning process, however over time the relationship between decoding and comprehension decreases (Catts et al, 2005). Within this study, we have a good cross-sectional example of that phenomenon. English L2 students are in the early stages of learning English and have not yet reached grade level proficiency in decoding; therefore we see a strong relationship between decoding and reading comprehension. On the other hand, English L1 students are at grade level on decoding and therefore this skill does not explain individual differences in reading comprehension.

Finally, different results were produced for the relationship between reading comprehension and comprehension strategies for English L1 and L2 students. For English L1 students comprehension strategies were significantly related to reading comprehension in the final model, this was not the case for English L2 students. However, a similar model of mediation was found in both groups where the relationship between decoding and reading comprehension was partially mediated by comprehension strategies. Future research is needed to examine the nature of the relationship between decoding, comprehension strategies and reading comprehension.

To answer hypotheses one and two, we conclude that a multiple component model of decoding, vocabulary knowledge, working memory, comprehension strategies, reading motivation and print exposure does the best job at explaining individual variations in reading comprehension performance for English L1 and L2 students. Furthermore, models of English L1 readers are appropriate for use in understanding reading comprehension in English L2 students. However, the relationship between the parameters in the model to reading comprehension is sensitive to the student's proficiency with English. Vocabulary knowledge is always critically important, but the influence of decoding, working memory and comprehension strategies changes depending upon language status (i.e., L1 or L2), and is bound to change with development and improved proficiency with English.

To answer hypothesis three, we conclude that reading motivation and print exposure are important constructs in understanding individual differences in reading comprehension performance, and should be added when building models of reading comprehension performance. The novel finding that emerged from this project was that reading motivation and print exposure have an indirect effect on reading comprehension. An even more interesting finding was that the mediator differed between groups. For English L1 students, vocabulary knowledge mediated the relationships between reading motivation and print exposure with reading comprehension. For English L2 students, the relationship of reading motivation and comprehension was mediated through comprehension strategies. Print exposure was not a significant predictor of reading comprehension for the English L2 students. The nonsignificant relation between print exposure and reading comprehension is most likely due to the low scores and low variability obtained by the English L2 sample. However, we predict that as the English L2 students' print exposure increases, a significant relationship between print exposure and reading comprehension will emerge, which may be mediated by comprehension strategies or vocabulary knowledge.

Implications

The findings from this project and previous research can outline research based instructional strategies that can be used by teachers, parents, volunteers, and others who are interested. The strategies focus instruction on the components found important in understanding reading comprehension ability. Direct instruction of vocabulary knowledge is critical for the improvement of reading comprehension ability. Both the breadth and depth of vocabulary knowledge should be taught by the use of semantic mapping to related words, to other concepts, or known concepts in the L2 students L1, as well as, talking about synonyms and antonyms, and providing multiple examples of the word being used in text. In addition, teaching the meaning of root words and how prefixes, suffixes, and compounding changes words will expand vocabularies and increase the quality of a lexical network (August & Shannahan, 2006, Siegel, 2009).

Comprehension strategies are a component necessary for the comprehension of advanced text. Helping students improve their ability to self monitor their comprehension of a passage, to self correct and re-read when comprehension fails, to inhibit other thoughts and focus attention, are some important strategies. In addition, figuring out unknown words in text, summarizing information and finding key points are also useful tools to use when reading (Presseley & Hilden, 2006; Siegel, 2009).

Furthermore, given their below grade level performance on a test of word reading accuracy some students in high school may benefit from explicit instruction on decoding and phonological awareness. Adolescents could benefit from learning how to identify syllables, onset-rimes, and phonemes in words. Also, learning how to blend words together and sound out unfamiliar words at a high school level will help increase their decoding skills and improve reading comprehension performance.

Finally, research supports the notion that students also need to have adequate world or background knowledge for comprehending certain texts (Presseley & Hilden, 2006; Siegel, 2009). Increasing interest in reading and print exposure is an excellent avenue for students to expand world knowledge and strengthen the other skills mentioned. For L2 learners, the use of dual language books and exercises, and visual aids are additional strategies shown to be useful when teaching English L2 children. The lessons needed to be delivered in manageable steps with good role models (Siegel, 2009). By incorporating the above strategies into all school subjects and curriculum, students who are struggling with reading will be getting gold standard instruction and will experience dramatic increases in their reading skills.

Limitation

Not measuring the English L2 students reading skills in their L1 was a limitation of this study. Being able to understand cross-linguistic influence of reading, language, and experience skills would have produced a much richer picture of the underpinnings of reading comprehension in English L2 adolescents. However, with 14 language represented in this study, developing an equivalent battery in all the languages samples would be a huge undertaking far beyond the scope of the current project. Measures in Cantonese, Mandarin, Spanish, and Persian/Farsi are in development. In time a much richer picture will unfold.

Conclusions

In closing, the reading skills of English L2 students are significantly lower than their English L2 peers, and are in need of remediation. For both groups, the measures of decoding, vocabulary, working memory and comprehension strategies were positively related to reading comprehension. The components related to reading comprehension for English L1 and L2 adolescents are somewhat similar. Both vocabulary knowledge and working memory had a direct relation with reading comprehension in both groups. A difference between groups was that decoding was significantly related to reading comprehension for English L2 but not L1 students. Another difference was that comprehension strategies were related to reading comprehension for English L1 students, but not for English L2 students when controlling for nonverbal reasoning, decoding, vocabulary knowledge and working memory. Reading motivation and print exposure were indirectly related to reading comprehension through vocabulary knowledge for the English L1 group, and motivation was indirectly related to reading comprehension through comprehension strategy use for the English L2 group. Instructional practices aimed at increasing English L1 or L2 students' reading skills should focus on all the components mentioned above while encouraging the student's interest in reading. Increasing student's literacy skills equips them with the tools needed for success in today's knowledge-based work force and economy.

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Table 1. Raw descriptive scores and groups comparisons of English L2 students with an Alphabetic (N=31) or Logographic (N= 23) L1

	Alphabetic				Logographic				
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.	F test of group difference
Reading Comprehension									
RC	16.94	9.84	4	40	22.65	9.26	12	43	F (1, 52) = 4.68, p = .035*
Vocabulary Knowledge									
Morphology	27.80	22.06	0	55	35.74	14.91	10	56	F (1, 50) = 2.44, p = .125ǂ
PPVT	116.58	41.74	37	186	118.13	40.89	54	184	F (1, 52) = .02, p =.892
Oral Vocabulary	18.00	6.85	4	35	19.43	6.10	10	33	F (1, 52) = .63, p = .429
Vocab. Rec.	.12	.14	-.10	.42	.11	.15	-.10	.40	F (1, 52) = .04, p =.85
EOWPVT	61.45	52.78	0	180	85.61	43.28	18	160	F (1, 52) = 3.21, p = .079
Decoding									
Word ID	70.90	18.83	32	100	76.09	13.40	51	100	F (1, 52) = 1.26, p =.266
Word Attack	26.29	10.57	4	39	28.30	8.00	10	43	F (1, 52) = .59 , p =.448
TOWRE SW	71.84	18.09	38	102	76.91	11.18	51	96	F (1, 50) = 1.41, p = .241ǂ
TOWRE PD	36.55	16.59	4	60	42.00	9.51	25	61	F (1, 49) = 1.99, p =.164ǂ
Working Memory									
WM reacall	24.35	9.53	9	41	27.78	8.70	16	42	F (1, 52) = 1.84, p =.181
WM T/F	29.45	8.37	19	47	32.65	7.46	21	42	F (1, 52) = 2.11, p =.152
Comprehension Strategies									
IDA	23.94	6.09	12	35	27.65	4.95	13	34	F (1, 52) = 5.74, p = .02*
Non-Verbal Intelligence									
MAT	14.06	9.50	0	29	27.96	2.77	19	32	F (1, 37) = 59.90, p <.001**
Print Exposure and Interest									
TRTT	.00	.13	-.22	.30	.05	.15	-.18	.39	F (1, 52) = 1.14, p =.24
Motivation	76.45	19.99	41	114	77.30	18.90	43	105	F (1, 52) = .03, p = .88

Notes. SD = Standard Deviation; RC = Gates MacGinitie Reading Comprehension Test; Morphology (MA) = Morphological Awareness; Vocab. Rec. (VR) = Vocabulary Recognition; TRTT = Title Recognition Test for Teens; Motivation (Motiv.) = Intrinsic Interest In Reading Inventory; IRA = Index of Reading Awareness; MAT = Matrix Analogies Reasoning Test; EOWPVT = Expressive One Word

Picture Vocabulary Test; PPVT = Peabody Picture Vocabulary Test; Oral Vocab (OV) = Woodcock Oral Vocabulary; TOWRE = Test of Word Reading Efficiency; SW = Sight Word Efficiency; PD = Phonetic Decoding Efficiency; Word ID = Woodcock Word Identification; Word Attack = Woodcock Word Attack; WM = Working Memory; ǂ = Brown-Forsyth correction (heterogeneous variances assumed);* $p < .05$, ** $p < .001$

Table 2. Pearson correlation matrix of variables with Alphabetic (N=31) above the diagonal and Logographic (N=23) below

	RC	VR	MA	EOW PVT	PPVT	OV	TOWRE SW	TOWRE PD	Word ID	Word Attack	IRA	WM recall	WM T/F	MAT	TRTT	Motiv.
RC	1	.795**	.727**	.771**	.687**	.742**	.656**	.484*	.749**	.641**	.706**	.747**	.748**	.687**	-.072	.412*
VR	.738**	1	.787**	.754**	.675**	.659**	.664**	.520*	.716**	.599**	.641**	.707**	.734**	.641**	-.162	.441*
MA	.862**	.688**	1	.885**	.786**	.740**	.772**	.454*	.763**	.555**	.610**	.618**	.623**	.700**	-.207	.479*
EOWPVT	.874**	.758**	.808**	1	.773**	.778**	.825**	.604**	.815**	.665**	.580**	.607**	.631**	.670**	-.134	.441*
PPVT	.873**	.762**	.780**	.909**	1	.845**	.789**	.591**	.769**	.652**	.341	.490*	.451*	.587**	-.109	.318
OV	.863**	.754**	.762**	.908**	.877**	1	.714**	.544*	.675**	.533*	.453*	.570**	.525**	.554**	-.045	.219
TOWRE SW	.541*	.445*	.634**	.519*	.456*	.485*	1	.701**	.890**	.746**	.390*	.481*	.484**	.463*	-.084	.337
TOWRE PD	.274	.456*	.330	.394	.434*	.352	.609**	1	.788**	.823**	.319	.224	.241	.151	-.042	.010
Word ID	.617*	.535**	.624**	.747**	.717**	.710**	.512*	.644**	1	.878**	.571**	.498*	.505*	.516**	-.043	.414*
Word Attack	.306	.422*	.358	.401	.394	.455*	.256	.473*	.795**	1	.520*	.352	.438*	.268	-.144	.245
IRA	.047	.105	.112	.048	-.069	.028	.385	.429*	.200	.194	1	.549**	.511**	.566**	-.094	.497*
WM recall	.682**	.418*	.550*	.567*	.561*	.635**	.367	.153	.421*	.310	-.107	1	.906**	.590**	.008	.325
WM T/F	.604*	.368	.488*	.503*	.517*	.595*	.316	.186	.443*	.415*	-.034	.897**	1	.518*	-.067	.304
MAT	.247	.039	.151	.064	-.016	.063	.139	-.371	-.073	.100	.006	.326	.325	1	.014	.530**
TRTT	.508*	.464*	.212	.625**	.583**	.603**	.007	.133	.417*	.177	-.208	.425*	.351	-.092	1	.138
Motivation	.289	.318	.351	.221	.195	.198	.463*	.418*	.384	.278	.459*	.254	.212	.071	.167	1

* $p < .05$ ** $p < .001$

Table 3. Hierarchical regression analyses examining predictors of reading comprehension in English L2 (N=54) adolescents

Model	Total R^2	ΔR^2	L1 group (β)	Non-Verbal Intelligence (β)	Decoding (β)	Vocabulary (β)	Working Memory (β)	Comprehension Strategies (β)
Independent variable order: (1) L1 group, (2) Decoding, (3) Vocabulary, (4) Working Memory, etc…								
1	.081	.081*	.284*					
2	.371	.290***	-.232	.746***				
3	.437	.066*	-.271	.738***	.260*			
4	.638	.201***	-.045	.395***	.268*	.512***		
5	.818	.181***	.076	.092	.287***	.620***	.474***	
6	.824	.006	.100	.026	.243***	.623***	.461***	.107

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

Final F (7, 45) = 35.95, $p < .001$

Table 4. Descriptive statistics and groups comparisons of English L1 (N=55) and L2 (N=54) variables.

	L1				L2				
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.	F test of group difference
Reading Comprehension									
RC raw	27.24	10	9	46	19.37	9.93	4	43	F (1, 107) = 16.99 **
RC stanine	3.85	2.15	1	9	2.26	1.77	1	7	F (1, 107) = 17.78 **
Vocabulary Knowledge									
Vocab. Rec. (VR) raw	.23	.12	.00	.47	.12	.14	-.10	.42	F (1, 107) = 22.40 **
Morphology (MA) raw	48.82	8.63	14	56	31.25	19.52	0	56	F (1, 71) = 36.12 ǂ**
EOWPVT raw	139.46	38.21	18	195	71.74	49.99	0	180	F (1, 107) = 63.28 **
PPVT raw	161.82	19.49	120	193	117.24	41.00	37	186	F (1, 75) = 52.00 ǂ**
PPVT ss	102.73	16.18	73	136	71.54	25.75	40	118	F (1, 89) = 57.09 ǂ**
Oral Vocab. (OV) raw	27.09	5.32	16	37	18.61	6.52	4	35	F (1, 107) = 55.41**
Oral Vocab. ss	102.84	21.41	28	147	79.65	17.41	44	129	F (1, 107) = 38.39 **
Decoding									
TOWRE SW raw	87.65	9.01	67	104	74.00	15.61	38	102	F (1, 107) = 31.43 ǂ**
TOWRE SW ss	99.29	9.96	74	123	83.39	16.98	9	117	F (1, 107) = 35.71 **
TOWRE PD raw	48.32	10.04	20	61	38.87	14.16	4	61	F (1, 95) = 16.07 ǂ**
TOWRE PD ss	100.15	13.11	67	124	87.48	15.70	55	118	F (1, 107) = 20.92 **
Word ID raw	88.84	9.78	61	102	73.11	16.79	32	100	F (1, 85) = 35.51 ǂ**
Word ID ss	100.58	14.47	57	139	75.80	26.07	17	119	F (1, 82) = 37.46 ǂ**
Word Attack (WA) raw	34.96	5.73	12	46	27.15	9.53	4	43	F (1, 87) = 26.80 ǂ**
WA ss	100.16	14.84	43	144	84.43	19.28	17	122	F (1, 100) = 22.73 ǂ**
Comprehension Strategies									
IRA raw (CS)	27.15	5.20	15	44	25.52	5.88	12	35	F (1, 107) = .01
Working Memory									
WM word recall	28.07	7.86	15	42	25.81	9.25	9	42	F (1, 107) = 1.89
WM true false correct	33.05	7.45	22	42	30.81	8.08	19	47	F (1, 107) = 2.26

Non Verbal Intelligence									
MAT raw	22.65	7.18	6	31	19.98	10.09	0	32	F (1, 96) = 2.53
Interest and Exposure									
TRTT raw proportion	.15	.16	-.18	.53	.04	.22	-.22	1.33	F (1, 107) = 22.40 ǂ**
Motivation raw	77.22	23.19	21	117	76.81	19.35	41	114	F (1, 107) =8.53*

Notes. SD = Standard Deviation; ss = standard score; RC = Gates MacGinitie Reading Comprehension Test; Morphology (MA) = Morphological Awareness; Vocab. Rec. (VR) = Vocabulary Recognition; TRTT = Title Recognition Test for Teens; Motivation (Motiv.) = Intrinsic Interest In Reading Inventory; IRA = Index of Reading Awareness; MAT = Matrix Analogies Reasoning Test; EOWPVT = Expressive One Word Picture Vocabulary Test; PPVT = Peabody Picture Vocabulary Test; Oral Vocab (OV) = Woodcock Oral Vocabulary; TOWRE = Test of Word Reading Efficiency; SW = Sight Word Efficiency; PD = Phonetic Decoding Efficiency; Word ID = Woodcock Word Identification; Word Attack = Woodcock Word Attack; WM = Working Memory; ǂ = Brown-Forsyth correction (heterogeneous variances assumed); * $p < .01$ ** $p < .001$

Table 5. Pearson correlation matrix of variables with English L1 (N=55) are above the diagonal and English L2 (N=54) below

	RC	VR	MA	EOW PVT	PPVT	OV	TOWRE SW	TOWRE PD	Word ID	Word Attack	CS	WM recall	WM T/F	MAT	TRTT	Motiv
RC	1	.567**	.589**	.608**	.605**	.759**	.282*	.379**	.534**	.295*	.424**	.518**	.435**	.525**	.462**	.484**
VR	.730**	1	.332*	.523**	.539**	.642**	.362*	.392*	.524**	.366*	.212	.472*	.430*	.326*	.509**	.484**
MA	.773**	.719**	1	.478**	.517**	.503**	.494**	.558**	.726**	.464**	.397*	.397*	.334*	.416*	.294*	.405*
EOWPVT	.821**	.723**	.863**	1	.547**	.623**	.174	.306*	.522**	.221	.199	.320*	.273*	.334*	.413*	.351*
PPVT	.735**	.711**	.763**	.804**	1	.719**	.287*	.362**	.610**	.389**	.244	.583**	.546**	.428**	.416**	.254
OV	.782**	.687**	.744**	.822**	.853**	1	.397**	.442**	.597**	.282*	.250	.547**	.477**	.415**	.493**	.474**
TOWRE SW	.624**	.564**	.748**	.739**	.666**	.645**	1	.750**	.582**	.495**	.380**	.262	.153	.296*	.203	.396*
TOWRE PD	.444**	.467**	.450**	.559**	.523**	.491**	.691**	1	.708**	.674**	.359*	.287*	.187	.393**	.385*	.378*
Word ID	.706**	.629**	.735**	.795**	.737**	.687**	.802**	.758**	1	.693**	.493**	.510**	.450**	.421**	.369*	.475**
Word Attack	.529**	.522**	.509**	.583**	.556**	.511**	.624**	.736**	.855**	1	.348**	.485**	.379*	.408**	.282*	.184
CS	.516**	.402*	.487**	.443**	.185	.323*	.412**	.380*	.480**	.429*	1	.209	.192	.323*	.186	.238
WM recall	.732**	.572**	.607**	.609**	.513**	.601**	.457**	.229	.485**	.349*	.354*	1	.925**	.380**	.339*	.294*
WM T/F	.708**	.567**	.595**	.604**	.471**	.558**	.448**	.251	.498*	.439**	.362*	.906**	1	.245	.244	.224
MAT	.585**	.323*	.568**	.540**	.328*	.391*	.407*	.197	.406*	.240	.528**	.484**	.454**	1	.365**	.193
TRTT	.099	.117	-.011	.131	.217	.155	.168	.121	.192	.051	-.263	.175	.137	.065	1	.395**
Motivation	.355*	.388*	.429**	.353*	.268*	.212	.366*	.125	.399*	.256	.464**	.296*	.268	.313*	.108	1

* $p < .05$ **$p < .001$

Table 6. Exploratory two factor model of English L2 (N=54) adolescents.

	English L2 Exploratory Factors 1	2
Vocab. Recognition	.489	**.648**
Morphology	**.548**	**.700**
EOWPVT	**.641**	**.659**
PPVT	**.630**	**.588**
Oral Vocabulary	**.555**	**.672**
TOWRE SW	**.771**	.397
TOWRE PD	**.897**	.046
Word ID	**.864**	.392
Word Attack	**.828**	.207
WM	.100	**.919**
WM recall	.130	**.886**
Eigenvalues	7.26	1.38
% of variance	65.96	12.58

Notes: Extraction Method: Principal Component Analysis with Eigenvalues ≤ 1; Rotation Method: Varimax with Kaiser Normalization

Table 7. Three factor model of vocabulary knowledge, decoding, and working memory for English L1 (N=55) and L2 (N=54) adolescents.

	English L1 Factors			English L2 Factors		
	1	2	3	1	2	3
Vocab. Recognition	**.701**	.207	.246	**.690**	.283	.366
Morphology	**.507**	**.581**	.124	**.787**	.297	.352
EOWPVT	**.825**	.331	.107	**.781**	.401	.336
PPVT	**.753**	.178	.384	**.856**	.319	.173
Oral Vocabulary	**.837**	.199	.243	**.821**	.276	.296
TOWRE SW	.229	**.809**	-.024	.584	**.619**	.182
TOWRE PD	.248	**.887**	.036	.280	**.876**	-.002
Word ID	.508	**.701**	.275	.516	**.769**	.242
Word Attack	.052	**.778**	.418	.221	**.876**	.236
WM Recall	.332	.187	**.891**	.360	.102	**.893**
WM T/F	.284	.076	**.924**	.278	.183	**.921**
Eigenvalues	5.99	1.59	1.0	6.65	1.37	.74
% of variance	54.48	14.49	9.22	66.46	13.68	7.26

Notes: Extraction Method: Principal Component Analysis (forced into three factors for L2 variables); Rotation Method: Varimax with Kaiser Normalization

Table 8. Hierarchical regression analyses examining predictors of reading comprehension in English L1 adolescents (N=55)

Model	Total R^2	ΔR^2	Non-Verbal Intelligence (β)	Decoding (β)	Vocabulary (β)	Working Memory (β)	Comprehension Strategies (β)	Motivation and Exposure (β)
Independent variable initial order: (1) Non-Verbal Intelligence, (2) Decoding, (3) Vocabulary, etc…								
1	.276	.276***	.525***					
2	.276	.001	.515***	.029				
3	.618	.342***	.258*	.114	.633***			
4	.656	.037*	.210*	.129	.651***	.198*		
5	.689	.033*	.182	.053	.622***	.183*	.208*	
6	.700	.011	.178	.015	.551***	.167*	.205*	.135
Independent variable reverse order: (1) Interest and Exposure, (2) Comprehension Strategies, (3) Working Memory etc...								
1	.321	.321***						.567***
2	.405	.084**					.299**	.491***
3	.427	.022				.150	.289*	.475***
4	.675	.248***			.592***	.192*	.252**	.162
5	.678	.003		.063	.609***	.197*	.228*	.140
6	.700	.023	.178	.015	.551***	.167*	.205*	.135

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

Final F (6, 48) = 18.68, $p < .001$

Table 9. Hierarchical regression analyses examining predictors of reading comprehension in English L2 adolescents (N=54)

Model	Total R^2	ΔR^2	Non-Verbal Intelligence (β)	Decoding (β)	Vocabulary (β)	Working Memory (β)	Comprehension Strategies (β)	Motivation (β)
Independent variable initial order: (1) Non-Verbal Intelligence, (2) Decoding, (3) Vocabulary, etc…								
1	.343	.343***	.586***					
2	.399	.056*	.554***	.239*				
3	.637	.238***	.360***	.265**	.524***			
4	.813	.176***	.150*	.294***	.589***	.463***		
5	.817	.004	.113	.259***	.586***	.449***	.087	
6	.818	.001	.112	.258***	.593***	.452***	.104	-.037
Independent variable reverse order: (1) Interest, (2) Metacognitive Strategies, (3) Working Memory etc...								
1	.127	.127**						.356**
2	.289	.163***					.463***	.128
3	.432	.143***				.401***	.350**	.092
4	.764	.332***			.601***	.436***	.294***	-.051
5	.811	.047***		.249***	.624***	.479***	.157	-.041
6	.818	.007	.112	.258***	.593***	.452***	.104	-.037

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

Final F (6, 46) = 34.50, $p < .001$

Figure 1. Mediation Model

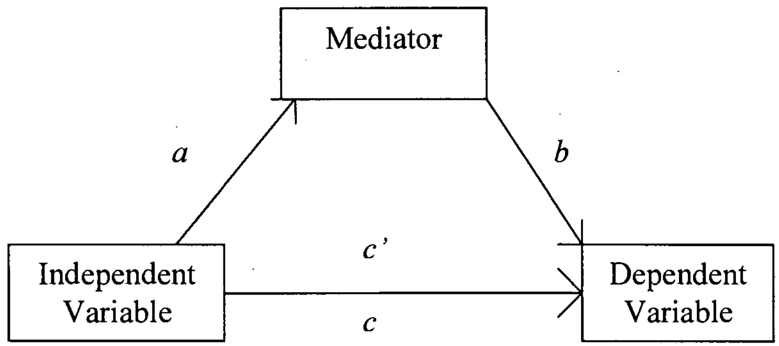


Figure 2. Mediation Model of Print Exposure through Vocabulary Knowledge to Reading Comprehension in English L1 adolescents, showing unstandardized beta weights (standard error) and standard beta weights

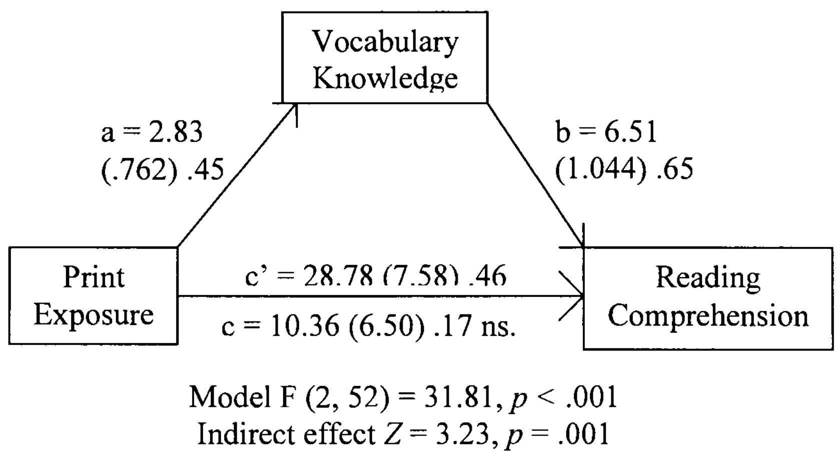
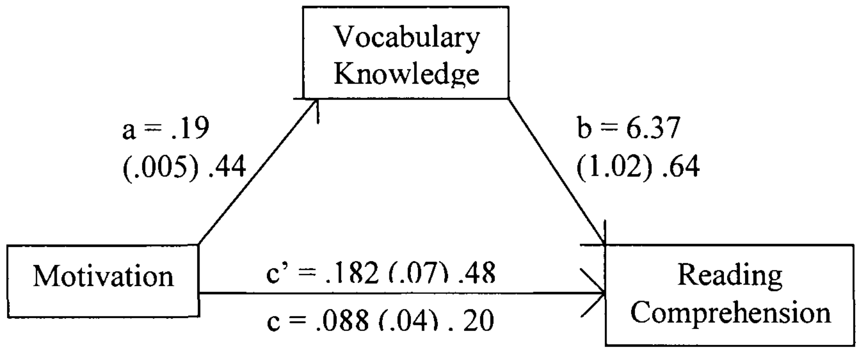
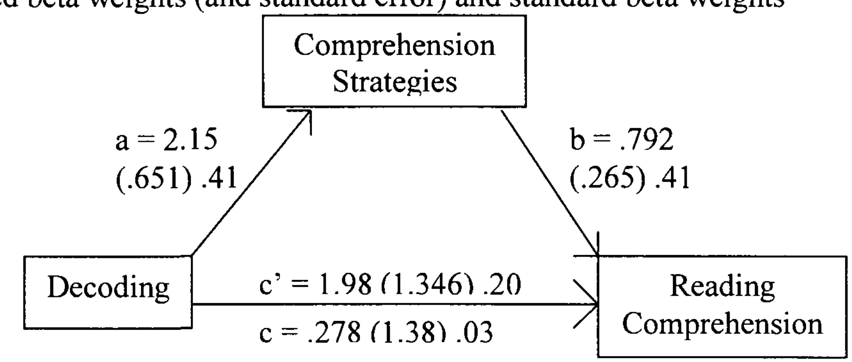


Figure 3. Mediation Model of Interest in Reading through Vocabulary Knowledge to Reading Comprehension in English L1 adolescents, showing unstandardized beta weights (and standard error) and standard beta weights



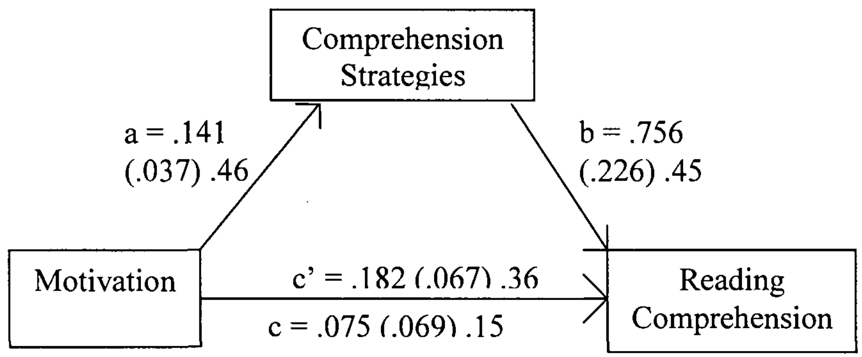
Model F (2, 52) = 33.34, $p < .001$
Indirect effect $Z = 3.13$, $p = .002$

Figure 4. Mediation Model of Decoding through Metacognitive Strategies to Reading Comprehension in English L1 adolescents, showing unstandardized beta weights (and standard error) and standard beta weights



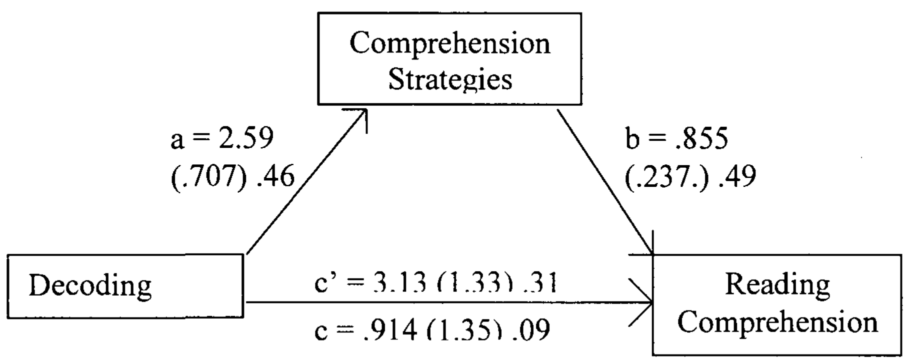
Model F (2, 52) = 5.72, $p = .005$
Indirect effect $Z = 2.25$, $p = .024$

Figure 5. Mediation Model of Interest in Reading through Metacognition to Reading Comprehension in English L2 adolescents, showing unstandardized beta weights (and standard error) and standard beta weights



Model F (2, 50) = 10.08, $p < .001$
Indirect effect $Z = 2.60$, $p = .009$

Figure 6. Mediation Model of Decoding through Metacognition to Reading Comprehension in English L2 adolescents, showing unstandardized beta weights (and standard error) and standard beta weights



F (2, 50) = 9.90, $p < .001$
Indirect effect $Z = 2.54$, $p = .01$

Appendix A: Vocabulary Recognition Form A

Below you will see a list of 80 words. Some of them are real words and some are made-up. You are to read the words and put a check mark next to the items that you know to be real words. Do not guess, but only check those that you know to be actual words. Remember, some of the items are real words, so guessing can easily be detected.

abaversive ______
abraded ______X
anable ______
antithetical ______X
astrology ______X
aversion ______X
binturong ______X
blumied ______
cairn ______X
cathology ______
colloquy ______X
commest ______
confiduity ______
coplanar ______X
cosmopalism ______
criteria ______X
cupumus ______
deluvial ______
dependable ______X
dilapidated ______X
disterging ______
ditalory ______
doppelate ______
eels ______X
egress ______X
emigrants ______X
engulled ______
floralism ______
graphotactic ______
groak ______
gusset ______X
gute ______
heartily ______X
hypothesize ______X
importunity ______X
ingenuity ______X
intermissions ______X
laciniate ______X
lacked ______X
lacrimation ______X
laquette ______
lastonic ______
lought ______
lugubrious ______X
lutch ______
menopath ______
metagogue ______
metasynthesis ______
modafaction ______
mollified ______X
objurgating ______X
ohm ______X
ordinances ______X
oscillating ______X
penneriful ______
pensile ______X
planomorphic ______
prefiant ______
prequisite ______
priance ______
propensity ______X
prostarative ______
queried ______X
recumbent ______X
rime ______X
sentiments ______X
staping ______
succumb ______X
tandem ______X
tarrizon ______
tonsorial ______X
traxive ______
trusdum ______
tuba ______X
uhr ______
unsmippen ______
verified ______X
vidically ______
vorcanize ______
zather ______

Appendix B: Title Recognition Test for Teens

A Light in the Attic ____
How to Eat Fried Worms ____
Call of the Wild ____X
*Joanne ____
*It's My Room ____
Hatchet ____
Tales of a Fourth Grade Nothing ____X
*Don't Go Away ____
*The Trouble with Tucker ____
Homer Price ____
*The Missing Letter ____
Heidi ____X
*The Rollaway ____
Freedom Train ____X
*Sadie Goes to Hollywood ____
James & the Giant Peach ____X
By the Shores of Silver Lake ____
Superfudge ____X
*The Case of the Unbreakable Walking Mirror____
*The Schoolhouse ____
*He's Your Little Brother! ____
Frankweiler ____
*Ethan Allen ____
*The Lost Shoe ____
Island of the Blue Dolphins ____
*Skateboard ____
Romona the Pest ____
Rumble Fish ____
*Tales of the Macabre ____
The Great Brain ____
*Searching the Wilds ____
Henry and the Clubhouse ____ X
*Hot Top ____
Dear Mr. Henshaw ____
Harriet the Spy ____X
*Treasure Island____ N
The Great Gatsby ____ N
*Oliver Twins ____ N
To Kill A Mockingbird ____N
*The Giant Elevator ____ N
The Catcher and the Rye ____ N
*And Then Their Was One ____ N
*The Winter Bear Business ____ N
The Thief ____ N
The Yearling ____ N
*Gears ____ N
Airborn ____ N
The Darkwing ____ N
*Oil and Fire ____ N
The Sweet Far Thing ____ N
*Fierce ____ N
New Moon ____ N
Guts ____ N
*Tears of a Lion ____ N
On Thin Ice ____ N
*The Hidden One ____ N
The Fire Within____ N
The Outsiders ____ N
*The Lunch Thief ____ N
The Subtle Knife ____ N
*The Halloween Party ____ N
The Giver ____ N
Roll of Thunder Hear My Cry ____ N
*Keeping the Sun ____ N
*Around the World in 30 Days ____ N
Open Ice ____ N
Skate ____ N
*The Crystal Spyglass ____ N
A Fate Totally Worse Than Death ___ N

*=foil
X=on TRT1
N=new item (adolescent revision)
40 Targets
30 Foils

Appendix C: Intrinsic Interest in Reading

The following are a number of statements with which some people agree and others disagree. Please circle one alternative below each statement according to the amount of your agreement or disagreement with that item. Which one you choose would indicate your own feelings based on everything you know and have heard. Note: there is no right or wrong answer.

1) Overall, I enjoy reading.
Strongly Disagree | Moderately Disagree | Slightly Disagree | Slightly Agree | Moderately Agree | Strongly Agree

2) Reading is fun to do.
Strongly Disagree | Moderately Disagree | Slightly Disagree | Slightly Agree | Moderately Agree | Strongly Agree

3) I would describe reading as interesting.
Strongly Disagree | Moderately Disagree | Slightly Disagree | Slightly Agree | Moderately Agree | Strongly Agree

4) I think reading is enjoyable.
Strongly Disagree | Moderately Disagree | Slightly Disagree | Slightly Agree | Moderately Agree | Strongly Agree

5) When I read, I think about how much I enjoy it.
Strongly Disagree | Moderately Disagree | Slightly Disagree | Slightly Agree | Moderately Agree | Strongly Agree

6) I like reading.
Strongly Disagree | Moderately Disagree | Slightly Disagree | Slightly Agree | Moderately Agree | Strongly Agree

7) I read for fun.
Strongly Disagree | Moderately Disagree | Slightly Disagree | Slightly Agree | Moderately Agree | Strongly Agree

8) If I could choose what to do right now, I would read a book.
Strongly Disagree | Moderately Disagree | Slightly Disagree | Slightly Agree | Moderately Agree | Strongly Agree

9) I think I am good at reading.
Strongly Disagree | Moderately Disagree | Slightly Disagree | Slightly Agree | Moderately Agree | Strongly Agree

10) I think I read well.
Strongly | Moderately | Slightly | Slightly | Moderately | Strongly

Disagree	Disagree	Disagree	Agree	Agree	Agree

11) After reading for a while, I feel skilled.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

12) I feel good about how well I can read.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

13) I am skilled at reading.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

14) Reading is an activity that I do well.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

15) When I choose a book to read, I can read it easily.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

16) I am a good reader.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

17) I put a lot of effort into reading.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

18) When I start reading a book, I try to finish it.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

19) Even when a book is hard to read, I stick with it.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

20) I like to read challenging books.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

Appendix D: Language Use Questionnaire

Date of Birth:_______________ Gender: M F

What grade are you currently enrolled in? ___________

1. a) Were you born in Canada? Yes No

   b) If you were not born in Canada, how old were you when you moved to Canada? __________

   c) In what grade did you start school in Canada? ___________

2. What language or languages are spoken at home?

   English French Other(s): _________________________

3. How often do you speak to the members of your household in **English**?

	Always	Frequently	Sometimes	Rarely	Never
Parent 1					
Parent 2					
Brothers & Sisters					
Grandparents					

5. How often do you speak to your friends in **English**?

	Always	Frequently	Sometimes	Rarely	Never
Friends at school					
Friends in community					

6. How often do you speak to your friends in your **native language**?

	Always	Frequently	Sometimes	Rarely	Never
Friends at school					
Friends in community					

6. How often do you watch TV or videos in English and in your **native language**?

	More than 2 hours per day	1-2 hours per day	2-5 hours per week	Less than 2 hours per week	Never
English					
Native Language					

7. How often do you read at home in English and in your **native language**?

	More than 2 hours per day	1-2 hours per day	2-5 hours per week	Less than 2 hours per week	Never
English					
Native Language					

8. Approximately **how many books** do you have around the house (including library books) in English and in your native language?

	0 - 5	5 - 10	10 - 15	15 - 20	25+
Friends at school					
Friends in community					