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Learning to Read in English: Vocabulary Knowledge, Phonological Awareness in Relation to Oral Reading Fluency in Chinese-English Bilinguals

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Abstract

Second language (L2) acquisition has received increasing interest due to the large number of people immigrating or learning an L2 (e.g., Statistics Canada, 2016). Word reading fluency has been found to be a strong predictor of text reading fluency and comprehension (Fuchs, Fuchs, Hosp & Jenkins, 2001). For people learning to read in L2, skills such as oral reading fluency serve as an indicator of overall reading competence in their L2. The current study examined oral reading fluency in relation to vocabulary knowledge, rapid naming (RAN) and phonological awareness in English and Mandarin in Chinese-English bilinguals. Participants included 40 Chinese-English bilingual adolescents and young adults, who have been in Canada for less than two years. During the one-year longitudinal study, participants were measured at 2 time points, approximately 12 months apart. Time 1 and Time 2 vocabulary, Time 1 RAN and Time 2 phonological awareness predicted English word reading fluency. Time 1 vocabulary predicted English text reading fluency. Overall, the findings of this research were consistent with previous theories. Although these late-sequential Chinese-English bilinguals demonstrated different profiles compared to their younger bilingual peers, their English skills became more native-like over the one-year period among our adolescent Chinese-English bilingual participants.

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Second language (L2) acquisition has garnered interest due to the large number of people immigrating and learning an L2, particularly in countries with large numbers of immigrants such as Canada (e.g., Statistics Canada, 2016). For people learning to read in an L2, skills such as oral reading fluency serve as an indicator of higher level processing in their L2. Word reading fluency has been found to be a strong predictor of text reading fluency and comprehension. In addition word reading fluency might be particularly important for older readers who are learning their L2 (Fuchs, Fuchs, Hosp & Jenkins, 2001). Fuchs, Fuchs, Hosp and Jenkins (2001) defined word reading fluency as the ability to efficiently translate written text into oral language with speed, whereas word reading accuracy refers to the ability to accurately identify words in print (Pasquarella, Chen, Gottardo & Geva, 2015). Together, accurate and efficient word recognition allows successful performance on more demanding reading tasks such as interpreting texts and paragraphs. In order to achieve skillful reading, children must master word reading accuracy and fluency in the early grades (Perfetti, 1985). However, for L2 learners who learn English in adolescence, word reading accuracy and fluency might be significantly behind their peers. Research shows that reading skills in the first language (L1) are positively related to the acquisition of L2 skills (Gottardo, Chiappe, Yan, Siegel & Gu, 2006). However, this may not apply when the languages differ substantially in their writing systems (e.g., Chinese & English), where cross language transfer of word reading fluency may demonstrate different patterns (Pasquarella, Chen, Gottardo & Geva, 2015; Gottardo, Koh, Chen, Jia & Pasquerella, 2017). With Chinese speakers being a large group of recent immigrants to Canada, the current study aims to advance our understanding of L2 acquisition in Chinese-English bilinguals, and lead to various educational policies and practices to promote successful reading acquisition.

Bilingualism in Canada

Immigrants constitute a large percentage of the population in Canada. According to the census released in 2016 from Statistics Canada, 21.9% of the population in Canada is categorized as immigrants. In addition, over the past 100 years, the percentage of immigrants who do not speak English or French as their L1 has changed from 21.5% to 71.2%. In order to achieve academic or economic success in Canada, it is crucial for immigrants to acquire one of the two official languages (English or French). Therefore, with the majority of the immigrant population facing the need to learn English or French as a second language, factors related to L2 acquisition have gained increasing interest among researchers and educators (August & Shanahan, 2006). Among the immigrant population in Canada, Chinese speakers are the third largest group of recent immigrants (Statistics Canada, 2016). Although past research has generated enhanced understanding of the relationship between L1 and L2 word reading skills when both languages are based on alphabetical scripts (Pasquarella, Chen, Gottardo &, 2015; Geva & Farnia, 2012), similar mechanisms may not apply when the L1 is a character-based language (Chinese). Additionally, most word level reading studies have focused on word reading accuracy as opposed to word reading fluency.

Sequential Bilingualism

One important characteristic used to differentiate L2 acquisition is whether the learners acquired their L1 and L2 at the same time, as simultaneous bilingual children, or at different times, such as children in Canadian immigrant communities who are often initially exposed to their family language (L1), before being immersed in English (L2). These children are typically referred to as sequential bilinguals (McCarthy, Mahon, Rosen & Evans, 2014). Research on second language learning in older sequential bilinguals has focused on reading comprehension

based on two factors: 1) the assumption that highly related L1 and L2 word reading skills transfer in a positive manner, and 2) the finding that despite average word reading, older L2 learners have weaker reading comprehension skills (Geva & Farnia, 2012). However, when the languages differ substantially at the phonological, syntactic and orthographic level (e.g., Chinese; a character based language and English; an alphabetical language), L1 word reading fluency skills may not support L2 word reading skills (Gottardo, Chiappe, Yan, Siegel & Gu, 2006). Previous research on younger Chinese-English bilinguals has found that students who acquired reading skills in their L1 and L2 at approximately the same time, performed similarly on word reading using similar strategies when compared to native English speakers, whereas students who were late sequential bilinguals tended to use different strategies to perform on the measure of word reading in English (Gottardo, Koh, Chen, Jia & Pasquarella, 2017; Chiappe, Siegel & Gottardo, 2002). The current study focuses on older Chinese-English bilinguals and examined the longitudinal changes in English word reading fluency skills in sequential bilingual Chinese-English learners who are young adults and are recent immigrants to Canada. More specifically, we are interested in examining which variables are most highly related to English oral reading fluency in Mandarin Chinese-English speakers.

Introduction to the Chinese Language

Unlike English, which is considered as a language with deep alphabetic orthography (Geva & Siegel, 2000), Chinese script relies on morpho-syllabic coding to map print onto speech and meaning (Leong & Tamaoka, 1998; Pasquarella et al, 2014). There are two types of characters in Chinese. Some characters do not have internal components that produce hints for pronunciation or meaning, such as 立/li 4/ (stand). This type of character can only be read by mapping the pronunciation and meaning onto the whole character. On the other hand, the

majority of Chinese characters are formed with two components, a phonetic compound and a semantic radical. For example, the character 粒 /li 4/ is used as a unit for agriculture products such as rice. It contains a phonetic radical 立 /li4/, which generates clues on the pronunciation of the character. It also includes the semantic radical 米 /mi 3/ (rice) which provides direction for the meaning of the character. However, the phonetic compound does not always produce useful information about pronunciation of the character. For instance, 位 /wei 4/ shares the same phonetic radical with 粒 /li 4/, yet the two have completely different pronunciation. Although beginner readers learn to read Chinese using Pin Yin, a pronunciation system that shares the same alphabet as English, skilled readers read in Chinese by recognizing characters from compound words (Leong & Tamaoka, 1998). Thus, reading in Chinese requires different strategies than reading an alphabetic language, such as English.

Cross Language Transfer

Research shows that reading skills in the L1 are positively related to the acquisition of the L2 (Gottardo, Chiappe, Yan, Siegel & Gu, 2006). However, this may not apply when the languages differ substantially in their writing systems (e.g., Chinese & English), where cross language transfer of word reading fluency may demonstrate different patterns (Pasquarella, Chen, Gottardo & Geva, 2015). Past research has shown that an individual who is literate in his L1 will become literate in his L2, if he receives sufficient exposure (Cummins, 1981). However, when the languages differ substantially at the phonological, syntactic and orthographic level, such as Chinese, which is a character based language, and English, which is an alphabetic language, bidirectional transfer of linguistic skills might not occur between the L1 and the L2 (Gottardo, Chiappe, Yan, Siegel & Gu, 2006). Therefore, people who speak Chinese as their L1 might face unique challenges when learning to read in English as their L2.

Past research on the cross-language transfer of skills involved in reading has generated mixed results. For example, Gottardo, Mueller, Baciu, Gu and Pauchulo (2010) found that performance on word reading was not related when tested in English and Chinese for simultaneous Chinese-English bilinguals in North America. Wang, Perfetti and Liu (2005) did not find relationships between word reading in English and Chinese in Grade 2 and 3 bilingual children in the United States. However, contradictory findings are reported by researchers from Hong Kong. Significant correlations were found for word reading performance between Chinese and English Grade 2 children in Hong Kong (Keung & Ho, 2009). Pasquarella and colleagues (2014) also observed cross-language transfer of word reading fluency in Grade 4 Chinese-English bilingual children in Canada. These conflicting findings might result from a different medium of instruction children have received in school or at home and the degree of exposure to each language. For example, reading instruction in Hong Kong involves "look-say" drill and practice in each language. Thus no stress or minimal stress is placed on the underpinnings of words (word families etc…), semantics or other features of instruction that could help to enhance comprehension.

Furthermore, the direction of cross-language transfer of linguistic skills between the L1 and L2 continue to be debated. Although some theories focus on the relationship between L1 and L2 skills (Cummins, 1984), other research has demonstrated that the acquisition of the L2 can influence the L1 in skilled readers (Cook, 2003). For example, Jared and Kroll (2001) found that English-French bilinguals activate spelling-to-sound correspondences from both languages simultaneously when performing word naming tasks. Pavlenko (2003) also found evidence of the influence of L2 semantic structures on the L2 through analyses of oral language errors made in the L1. However, the limited number of studies that have examined the effects of L2 language

and literacy skills on L1 language skills have focused on alphabetic languages. Therefore, it is not clear whether such patterns of cross-language transfer can be observed when the L1 is a character based language such as Chinese.

Psycholinguistic Grain Size Theory

The psycholinguistic grain size theory (PGST) proposed by Ziegler and Goswami (2005) addresses the difference between language systems and their related acquisition processes, by taking into account the differences in scripts, languages and sound-symbol relations. This universal theory of reading acquisition suggests that there are language differences in terms of how orthography maps onto phonology and morphology across different languages (Ziegler & Goswami, 2005). Ziegler and Goswami (2005) proposed three factors that contribute to reading among beginner readers. The factors are: availability, consistency and granularity. Availability refers to the ease of access of different sound units prior to reading. Consistency can be seen in the association between each sound and symbol of the language. Granularity refers to the level of mappings between the sound and symbol in a language to determine if they are larger or smaller units. However, all three factors pose some problems. For example, 1) the concept of availability assumes that some phonological units are not as readily available and thus would require more cognitive development. 2) Consistency suggests that the inconsistency in pronunciation and/or spelling of phonological units will slow reading development. 3) Granularity refers to the fact that the access to the phonological system is dependent on the orthographic units to be learned by readers. The PGST suggests there is cross language variation on the efficiency of solving these three problems, thus resulting in different processes related to reading acquisition in different languages (Ziegler & Goswami, 2005).

When languages possess systematic differences in their writing systems, such as English, Korean and Japanese (Yoon, Bolger, Kwon, & Perfetti, 2002; Goswami, 2008), learners of the language will develop different processes to deal with the grain size, which will affect the acquisition of written language (Goswami, Ziegler & Richardson, 2005). Past studies have found that children learning an alphabetic language such as English develop awareness of phonemes early in their learning (Pattamadilok et al, 2017), whereas children learning a character based language such as Chinese will not demonstrate such development (Gottardo, Chiappe, Yan, Siegel & Gu, 2006). Compared to English, Chinese characters lack sound-letter correspondences in their written language. Therefore, these findings support the prediction by PGST that reading in Chinese incorporates different strategies compared to reading in an alphabetic language such as English (Goswami, 2008).

Oral Reading fluency as an Indicator of Language Competence

For people learning to read in their L2, skills such as oral reading fluency serve as an indicator for higher level processing in their L2. Although word reading accuracy is often the focus of word reading research, word reading fluency is important for text comprehension (Farnia & Geva, 2013, Jenkins et al. 2003). Word reading fluency and text reading fluency are two common forms of assessment for oral reading fluency (Fuchs et al., 2001; Geva & Farnia, 2012). Word reading fluency is a strong predictor of text reading fluency and comprehension (Fuchs et al. 2001). The accuracy and rate of reading lists of isolated words or pseudowords serves as a common assessment for reading fluency, especially for beginner readers who struggle with reading connected text or paragraphs (Jenkins et al. 2003). Previous studies have shown that word reading fluency serves as a strong predictor of text reading fluency and comprehension in children at an early age (Farnia & Geva, 2013, Jenkins et al. 2003) and for people who are

learning English as their L2 (Pasquarella, Chen, Gottardo & Geva, 2014). Farnia and Geva (2013) suggested that word and text reading fluency largely overlap with one another in Grade 1 children, and word reading fluency serves as a stable predictor of Grade 6 reading comprehension. Pasquarella and colleagues (2014) have found transfer of word reading fluency occurring between the L1 and L2 in English language learners (ELL) children who are native Chinese or Spanish speakers. Word reading fluency in the L1 predicted unique variance in word reading in the L2 for both Grade 2 Spanish-English and Chinese-English bilingual children, showing cross language relations. However, cross-language transfer of word reading accuracy was only observed in Spanish-English bilingual children. Chinese-English bilingual children did not demonstrate transfer of word reading accuracy skills between L1 and L2 and that was attributed to script differences (Pasquarella, Chen, Gottardo & Geva, 2014).

Past studies have used a combination of both reading isolated words and connected texts to assess reading fluency (Jenkins et al, 2003, Geva & Farnia, 2012). Previous literature has suggested that while isolated word reading is less dependent on higher level linguistic skills, text reading fluency is better linked to language skills (Wolf & Katzir-Cohen, 2001). Wolf and Katzir-Cohen (2001) suggested that unlike isolated word reading that happens automatically, text reading fluency is an indication of higher language skills including vocabulary and deeper comprehension. Geva, Wade-Wooley and Shany (1997) suggested that when L2 learners achieve a certain level of language proficiency, text reading fluency and language skills are positively related to each other. A study conducted by Jenkins et al. (2000) examined word reading fluency and text reading fluency in 113 fourth-grade students. They found that although word reading and text reading fluency together explained 70% of the variance in reading comprehension, text reading fluency uniquely explained 42% of the variance, yet word reading fluency alone only

explained 1% of the variance. Therefore, while word reading fluency might be a better predictor of reading comprehension for beginner L2 learners, text reading fluency may be better at predicting reading comprehension in more proficient L2 learners (Geva & Farnia, 2012; Jenkins et al, 2000). The previous studies have examined word reading fluency in elementary school-aged children. However, the current study examines word reading fluency in adolescent L2 learners.

One of the theories that supports the role of reading fluency is the automaticity model of reading put forth by LaBerge and Samuels (1974). This bottom-up serial-stage theory suggests that attention is a key explanatory construct in reading. Automatic lower level word reading processes allow for the allocation of attention to perform more skillful reading required for reading comprehension. When each component in reading requires attention, the set of lower order skills required for reading will exceed the capacity of attention, and therefore, create burdens for completing higher order reading tasks. On the other hand, when some lower order reading skills can be executed automatically, attentional capacity is sufficient to allow for successful performance in reading (LaBerge & Samuels, 1974).

Building upon LaBerge and Samuels' theory, Kuhn, Schwanenflugel and Meisinger (2010) proposed a model describing four properties of automatic word reading: speed, effortlessness, autonomy and lack of conscious awareness. First of all, word identification happens within one second due to fast decoding, a skilled reader retrieves words from long-term memory upon encountering words. Second, automatic word decoding is effortless so that it frees attentional capacity and allows simultaneous comprehension of the content of text. Third, the recognition of words happens in an obligatory manner, the spoken sound and meaning of a word will be available to the reader as soon as the word is presented visually. This happens without

intention, using other skills such as phonological awareness, orthographical processing or morphological awareness. Finally, word reading happens without consciousness, the reader cannot decide to identify the word if it is presented visually (Kunh et al, 2010; Laberge & Samuels; 1974, Fuchs et al, 2004).

Previous research in neuropsychology has also provided supporting evidence for the location and execution of automaticity of word reading. Coleman (2018) suggests that fluent reading can be performed via an automatic and relatively fast lexical access process. This process involves activating one memory location and automatically spreading to semantically related memory locations in a network in long-term memory. This network involves the posterior, temporal and prefrontal regions of the brain, and is fast-acting and requires low attention capacity (Coleman, 2018, Pattamadilok et al, 2017).

Seidenberg's (2007) connectionist theory of reading has also provided an explanation for word reading by modeling possible neural mechanisms. He proposed that in order for beginner readers to accurately compute the pronunciation of words, it is essential to find the appropriate set of weights linking spellings of words to their pronunciations and meanings. The model suggested that readers incorporate an automatic mechanism that includes both "rule-governed" forms and "exceptional" cases when encountering words with inconsistent spelling-sound correspondances such as "gave-have". Language learners use "rule-governed" as well as "exceptional" forms in a statistical manner with word-specific spelling-sound correspondences represented in the brain as relations on a continuum. It is essential to master these spelling-sounds correspondences in order to achieve accurate and efficient word reading (Seidenberg, 2007).

The current study includes adolescents and young adults who are learning English as their L2, for whom English was introduced in middle school or later. As late sequential bilinguals, it is debatable whether word reading fluency or text reading fluency will be better suited as a measure of language competence. Therefore, the proposed study used both isolated word reading tasks measuring accuracy and fluency as well as text reading fluency tasks to further explore the bottom-up automatic mechanisms of oral reading fluency.

The Role of Phonological Processing

Phonological processing is defined as the perception, manipulation and analysis of sound units in any language (Goswami & Bryant, 1990). Specifically, the ability to be aware of and to access the phonology of a language is referred to as phonological awareness (Wagner & Torgesen, 1987). Phonological awareness (PA) can be further categorized into finer skills such as awareness of compound structure, onset-rime, body-coda and phonemes as well as knowledge of polysemy (Lin, Cheng, & Wang, 2017; Yoon, Bolger, Kwon, & Perfetti, 2002). Pattamadilok and colleagues (2017) suggested that phonological awareness is automatically activated during visual word recognition. Skillful readers of an alphabetic language are able to efficiently convert written words into spoken language using phonological awareness. In contrast, individuals without well-developed PA will find it more demanding to transfer written symbols into sound (Wagner & Torgesen, 1987).

A large body of past research has found PA to be a strong predictor of word reading and reading comprehension in alphabetic languages (Linan-Thompson, Vaughn, Prater & Cirino, 2006; Lesaux & Siegel, 2003). However, despite the extensive research in this field, previous findings on cross language transfer of phonological awareness have reported mixed results. Some researchers suggest that cross-language transfer of PA occurs at a more abstract level,

involving metalinguistic skills, particularly when learning to read in an L2 that is distant from the L1 (Kuo & Anderson, 2006; Wang, Perfetti & Liu, 2005). For example, Tong, McBride, Shu and Ho (2017) found that Chinese phonological awareness was correlated with performance on English comprehension in 10-year-old Chinese English bilinguals from Hong Kong. Other studies have found bi-directional cross-language transfer of PA skills in Chinese-English bilingual children who are students either in China or Canada (China; Lin, Cheng & Wang, 2017; Canada; Gottardo, Yan, Siegel & Wade-Woolley, 2001). Researchers reported a significant effect of rime-awareness on English word reading and reading comprehension as well as direct effect of English phoneme awareness on Chinese word reading (Lin et al., 2017). Furthermore, a one-year longitudinal study found that Chinese syllable awareness significantly predicted both current and future English word reading (Chow, McBride-Chang & Burgess, 2005). On the other hand, other researchers believe that while some linguistic components are language universal (August & Shanahan, 2006; Cummins, 1984), other components of language acquisition can be language specific (Gottardo, Chiappe, Yan, Siegel & Gu, 2006). According to the psycholinguistic grain size theory proposed by Ziegler and Goswami (2005), Chinese, as a morpho-syllabic script, differs substantially on orthography-phonology correspondences from an alphabetic language such as English. Therefore, Gottardo, Koh, Chen and Jia (2017) suggested that phonological awareness was not related to word reading in English in recent Chinese immigrants in Canada. Similar findings were reported by Li, Tao, Joshi and Xu (2107). This research has shown that although English phonemic awareness is associated with poor performance on English reading, Chinese phonemic awareness is not linked to English reading performance in older learners.

The Role of Rapid Naming

The double-deficit hypothesis proposed by Wolf and Bowers (1999) suggested that deficits in phonological processing and rapid naming are the result of two separate mechanisms of reading dysfunction. Therefore, rapid naming is as important as phonological awareness when learning to read (Wolf & Bowers, 1999; Wolf, Bowers & Biddle, 2000). Rapid digit naming (RAN) has been found to be significantly related to skilled reading (Kirby, Georgiou, Martinussen, & Parrila, 2010). A recent study has found RAN is a significant and unique predictor of English word reading in average and good readers (McIlraith, 2018). The significance of RAN in relation to word reading has also been examined across different writing systems (Zhang & Lin, 2018; Altani et al., 2017; McBride-Chang et al., 2013). Altani and colleagues (2017) found that rapid serial digit naming plays a universal role in relation to word reading. The effect of RAN on word reading did not differ among Chinese, Korean, English and Greek students. Furthermore, a subsequent study conducted in Hong Kong has suggested that RAN predicted later word reading competence in Chinese kindergarten children (Zhang & Lin, 2018). The current study aims to further explore the effect of RAN on English word reading fluency in sequential Chinese-English bilinguals.

The Role of Vocabulary

Although vocabulary plays a prominent role in second language acquisition, it has mostly been treated as a control variable in previous studies (Tong, McBride-Chang, Ho, Waye & Chung, 2017; Tong, Tong & McBride-Chang, 2017). Vocabulary knowledge includes two dimensions, breadth and depth, that are closely related to each other. Vocabulary breadth refers to the quantity of known words, whereas vocabulary depth represents the level of comprehension one has for specific vocabulary items (Ouellette, 2006; Qian, 1999). Previous research has found that vocabulary breadth is more highly related to word reading compared to vocabulary depth

(Cain & Oakhill, 2014). Zhang (2012) found that English vocabulary significantly predicts reading comprehension in English among Chinese ELL adults. When other cognitive linguistic variables were included in the analyses (e.g., morphological awareness, derivational awareness), vocabulary has been found to play a mediating or facilitating role in L2 acquisition (Tong, Tong, McBride-Chang, 2017; Chen, Ramirez, Luo, Geva & Ku, 2012). Growth in expressive vocabulary has been found to be related to children's lexical quality, and in turn, improve reading development (Perfetti & Hart, 2002). A previous study has found expressive vocabulary growth predicted English word reading in children from Hong Kong (Liu, Yeung, Lin & Wong, 2017). However, due to the differences of education and instruction received by children in Hong-Kong (a look-say approach), this theory may not apply to children in North America or recent immigrant children or young adults in Canada. Previous studies conducted in North America have found that English vocabulary breadth contributed a large amount of variance to English word reading among Chinese-English bilingual children (Wang et al., 2006; Wang et al., 2009). To further explore the role of vocabulary in English word reading, this study uses both expressive and receptive vocabulary assessments to further examine the relationship between vocabulary and word reading in Chinese-English bilinguals.

The Role of Motivation

Motivation is a key factor related to the acquisition and development of the L2. L2 learners who are more motivated to participate in their new culture are also more likely to put forth increased effort in acquiring L2. According to Schumann's (1986) unidimensional acculturation model, identification with the target culture is a key factor relating to L2 acquisition. Learners are more likely to succeed in L2 acquisition when they positively identified with the target culture (Schumann, 1986). In addition to Schumann's acculturation model,

Gardner's socioeducational model suggested that individuals' willingness to acquire their L2 is related to their aptitude and attitude toward the mainstream culture through increased interactions with the mainstream language community (Gardner, 1985). Previous studies have found that time spent on comprehending text is significantly related to the level of motivation possessed by students (Schumann, 1986; Masgoret & Gardner, 1999). Jia, Gottardo, Koh, Chen and Pasquarella (2014) have found that the level of acculturation to Canadian society is an independent contributor predicting literacy skills in English among adolescent Chinese immigrants from Grades 7 to 12 (Jia et al., 2014). The present study includes questionnaires as an assessment of motivation and acculturation. The role of motivation in relation to L2 acquisition is explored among this group of Chinese-English bilingual adolescents.

The Current Study

The current study examined the development of English reading skills in adolescent Chinese-English readers, who were recent immigrants to Canada. The research project extended existing research by examining if and how English word reading becomes more like the reading of native English speakers (more native-like)[1] over time in adolescents who speak Chinese as their first language and whether there are changes in performance over a one-year period. With Chinese speakers being one of the largest group of recent immigrants to Canada (Statistics Canada, 2016), understanding the patterns of L2 reading acquisition in Chinese-English speakers could lead to the development of better programs to assist recent immigrants in becoming more proficient readers.

A large body of recent research in the field of second language learning and literacy development has focused on younger children who are exposed to their L2 at an early age.

[1] The phrase more "native-like" involves increased levels reading skill and relationships between reading related skills that are more similar to those found in native speakers in the literature.

However, only a few studies have examined L2 word reading development in adolescents or young adults, who are introduced to their L2 in middle school or later. Therefore, the present study focused on Chinese-English bilingual adolescents and young adults who learned English in middle school or later. Given that previous research has generated mixed results on cross language transfer of word reading and its related strategies (Fuchs, Fuchs, Hosp & Jenkins, 2001; Pasquarella, Chen, Gottardo & Geva, 2014), the current study aimed to further examine the development of oral reading in Chinese-English bilinguals. The present study also considered motivation and acculturation as other factors of second language acquisition. The current study included one motivation and acculturation questionnaire to assess if motivation played a role in the acquisition of L2 reading fluency in Chinese-English sequential bilinguals over a one-year longitudinal period.

The major research question in relation to sequentially bilingual Chinese-English learner was to explore the extent to which these variables were most highly related to English oral reading fluency in Chinese-English speakers. The current study examined oral reading fluency in relation to vocabulary knowledge, rapid naming (RAN) and phonological awareness in English and Mandarin for Chinese-English bilingual adolescents and young adults who have been in Canada for less than two years. This was addressed through the following research questions and hypotheses. 1) Which variables are most highly related to English word reading fluency in Chinese-English speakers? It was hypothesized that phonological awareness in both English and Chinese are key variables relating to word reading fluency and accuracy in English. Furthermore, it was also expected that word reading fluency is significantly related to vocabulary knowledge in both languages. 2) Which variables are most highly related to English text reading fluency in Chinese-English speakers? Past research has shown that text reading fluency predicts higher-

level reading skills in more proficient readers. We hypothesized variables related to text reading fluency should demonstrate similar patterns compared to word reading fluency. 3) Does English word reading become more native-like over time? Although the literature shows that younger students acquire patterns of word reading more similar to native speakers of English over time, the participants in this study may not demonstrate such pattern given that they are young adults. 4) Does the level of motivation and acculturation to Canadian culture predict literacy skills in English in older Chinese-English bilingual adolescents? We hypothesized that L2 learners who are more motivated to participate in their new culture are also more likely to put more effort into acquiring L2.

Methods

Participants

The participants were Chinese-English speakers of Mandarin Chinese who had been in Canada for less than two years. Forty international students enrolled in the first year of their undergraduate program were recruited at the beginning of winter semester for Time 1 of the study, including 13 males and 27 females (M_{age} = 20.40, *SD* = 3.56). Among the 40 participants, 31 of them completed high school level education in China, 6 studied in China until grade 11, and 3 of them completed a university level education in China. The same cohort of students was contacted again for testing after approximately 10 to 12 months for Time 2 of the study, 32 out of 40 students participated at Time 2 of the study, including 8 males and 24 females (M_{age} = 20.67, *SD* = 3.82). Students were recruited from two medium sized Canadian universities in Ontario, Canada. Students from one University received one percent of the course participation credit equivalent or $45 as compensation for participation, students from the other University received $45 as compensation for participation.

Measures

All the English measures used in the study were standardized. Participants were tested in English on word reading, phonological processing, vocabulary knowledge and RAN. Chinese tasks measuring corresponding constructs were administered in Chinese to determine a baseline for L1 reading skills. These tasks were developed by experts in L2 acquisition in Chinese-English bilinguals (Gottardo, Chen and Koh) and have been used extensively in research conducted and published by Gottardo and Chen and their colleagues (Pasquarella, Chen, Gottardo & Geva, 2014; Gottardo, Koh, Chen & Jia, 2017). The tasks used for the current research project were based on the Chinese education curriculum and show high reliability.

Word Reading (English and Chinese). For English word reading, standardized tests from the Woodcock-Johnson Test of Achievement III (WJ III: Woodcock, 1998) of word and pseudoword reading accuracy were administered. WJ-III Word Identification subtest measures the accuracy of word reading. Participants were presented with 106 English words, progressing from easy to difficult. The list begins with "is: and terminates with "zeitgeist". The test is discontinued when participants incorrectly read six words in a set, or had attempted all the words without reaching the ceiling criterion. WJ-III Word Attack assesses the accuracy of pseudoword reading. Participants were presented with a page contains 45 pseudo words. The list begins with "dee" and ends with "pnomocher". Basal and ceiling rules are the same as the word identification task.

English Fluency was measured using the standardized Test of Word Reading Efficiency (TOWRE) (Torgesen, Wagner, & Rashotte, 1999) to assess the accuracy and fluency of word and pseudo word reading. Participants were asked to read a list of 104 words in 45 seconds, and told to read as quickly and as accurately as they could. The list began with "is" and ended with

"translent". TOWRE phonemic coding efficiency measures pseudoword reading fluency. For this subtest, the same instruction were given. The list contained 63 pseudowords from "ip" to "emulbatate".

Chinese Word Reading was measured by using both an adapted version of TOWRE to measure fluency and a character reading task to measure accuracy. For the translated TOWRE task, participants were presented with a list of 96 characters and compound words arranged by level of difficulty. They were instructed to read as many words as they can in 45 seconds. Time and accuracy were recorded. For the character reading task, participants read a list of 100 characters arranged by frequency and complexity. The task was discontinued when participants incorrectly read 10 words in a row.

Text Reading Fluency. Given the fact that participants were first-year university students, two English passages were selected from the TOEFL (Test of English as a Foreign Language) reading component to match with appropriate level of difficulty. Both passages contained approximately 60 words. Time and accuracy were recorded separately for both passages. Participants were instructed to read the passages as accurately and quickly as they could. Chinese text reading fluency used a similar procedure. Participants were presented with two passages in Chinese at a university level, each containing approximately 200 words. Time and accuracy were documented for each passage.

Rapid Digit Naming (English and Chinese). Participants were assessed on Rapid Automatized Naming (RAN) (CTOPP-2; Wagner et al., 2013). They were asked to read a set of numbers as fast and as accurately as they can. Participants were told at the beginning of each session that this task would be timed. The time and accuracy of numbers read were recorded

separately for each set. The same task with different numbers were used for Chinese. Participants were asked to read the numbers in Chinese.

Vocabulary Knowledge (English). Breadth of both receptive and expressive vocabulary knowledge were assessed. The Peabody Picture Vocabulary Test - 4 (PPVT-4) was used in this study as a test of L2 vocabulary knowledge. PPVT-4 contains 12 sets real word items, a total of 228 items are organized by difficulty and divided into sets that are labeled by age. Since our participants were international students who were learning English as their L2, they did not begin with their corresponding age set. All of the participants started at the Age 8 set. Participants were presented with 4 pictures at a time, and were asked to pick a picture corresponding to the item they hear from the tester. Basal was established when 0 to 1 mistake were made in a set of 12 items. The test terminated when participants incorrectly identify 8 or more items in one set. EOWPVT contains 170 items with increasing level of difficulty. Participants were presented with 1 picture at a time, and asked to describe the object in the picture with 1 word. The pictures begin with “dog” and end with “dolman”.

Phonological Awareness (English and Chinese). The pseudoword elision subtest of the standardized Comprehensive Test of Phonological Processing (CTOPP-2: Wagner, Torgesen, Rashotte & Pearson, 2013) was used to measure phonological awareness. Given that participants were first year university students, a PigLatin task was administered instead of word elision from CTOPP-2 to adjust the level of difficulty.

For the elision task of the CTOPP-2, participants were instructed to delete a phoneme from words or pseudowords and to articulate the remaining word after the deletion. For example, say “smool”, now say “smool” without saying “m”.

For the PigLatin task, participants received instructions on how to change words into a new code called PigLatin. The instructions included three things; first participants needed to take the first sound off the front of the word; and then they needed to put that sound at the end of the word; then they needed to add the sound "ay". For example; "Pin" would be "in-pay", "stick" would be "tick-say", and "charge" would be "arj-chay". A total of 26 items were administered; participants received feedback on the first 9 items. Word elision from CTOPP-2 was used to assess phonological awareness when participants are unable to perform on PigLatin task. Reliability for the sample on this task was Cronbachs $\alpha = .91$ at Time 1 and $\alpha = .81$ at Time 2.

Given the fact that participants were native Chinese speakers and the majority of them completed high school in China, a Chinese version of the PigLatin task was used instead of the elision task. Chinese PigLatin used similar instructions as the English version of PigLatin, except that participants were told to add the sound "ah" at the end of the word instead of "ay". This is because "ah" is the most commonly used vowel in Chinese. Participants were given words in Chinese and told to recode them into Piglatin. For example, "duo (3)" would be "uo(3)-da", and "chuan(2)" would be "uan(2)-cha". A total of 14 items were administered.

Motivation and Acculturation. Motivation to learn English and acculturation versus maintaining Chinese culture was measured using the Vancouver Index of Acculturation (VIA). The VIA was administered because it assesses mainstream acculturation and heritage enculturation separately (Ryder, Alden & Paulhus, 2000). Using a Likert-type scale, participants wre asked to circle a number between 1 to 5 (1 being not at all and 5 being almost always) to each item that best applies. A total of 25 questions were administered, including items such as "I enjoy English language movies", "I eat/cook Chinese food" etc.

Procedures

Ethics approval was received from Wilfrid Laurier University. The study was posted on the research participant site at the University, and on a Chinese Student Association website at a nearby university. Students, received either one course credit through the research participant pool or $45 as compensation for participation. Data collection took place at two time points that were approximately one year apart. All participants were tested in English and Chinese. The majority of English measures were standardized. Participants were tested in English on word reading, phonological processing, oral and written lexical access and orthographic processing. Chinese tasks were developed by researchers with extensive experience creating tasks in Chinese. The Chinese tasks showed high reliability and are based on reading lists from Chinese curriculum. Participants were also tested on word reading, pseudocharacter reading, orthographic choice and vocabulary knowledge in Chinese. All participants received instructions regarding the measures in both English and Chinese. The order of administration of the measures was randomized during testing sessions. Consent forms were given to participants upon arrival at the lab. Participants were told that participation was voluntary and they may withdraw from the study at anytime without any adverse consequence. Participants were tested by a graduate student who was trained in all measures, the participants worked one-on-one with the researcher in a quiet room at one university. The study took approximately 2 hours at both time points. At Time 1, each participant was scheduled for two testing sessions, with each session being approximately one hour. At Time 2, each participant was scheduled for one testing session that was two hours in duration. They were tested in both English and Mandarin Chinese, with Chinese measures being administered first. English measures took approximately 1 hour and 30 minutes to complete, while Chinese measures took approximately 30 minutes. Participants also

completed the motivation and acculturation questionnaire at the end of the session at Time 2. Participants were debriefed and paid at the end of the testing session.

Results

Descriptive Statistics

All participants were included in the analyses: 40 participants at Time 1 (13 males and 27 females) (M_{age} = 20.40, *SD* = 3.56), and 32 participants at Time 2 (8 males and 24 females) (M_{age} = 20.67, *SD* = 3.82). Mean comparisons between participants who dropped out and who participated at both time points did not demonstrate significant differences on scores across measures (See Appendix A). Table 1 illustrates the means and standard deviations for each task for all of the participants at both time points. No ceiling or floor effects were found from visual inspection of the data for all English measures and the majority of Chinese measures. The Chinese phonological awareness task (PigLatin) at time 2 showed the possibility of ceiling effect. This restricted range of responses could result in non-significant relations with other measures. Therefore, the outcomes of analyses that included this measure were interpreted cautiously.

Correlational analyses

The correlations within languages for the L1 (Chinese) variables and L2 (English) variables and across languages (Chinese & English) were analyzed and presented in Tables 2 and 3. Table 2 illustrates correlations among all variables at Time 1. Table 3 illustrates correlations among all variables at Time 2. For parallel measures that contained different numbers of items, percent correct values were used to perform the correlational analyses.

Relationships among L1 (Chinese) and L2 (English) variables at Time 1.

Within language relations at Time 1 were examined for the English variables. English vocabulary at Time 1 was related to English word reading fluency at Time 1, $r_{(38)}$ = .628, p <

.001, English RAN at Time 1, $r_{(38)} = -.383$, $p = .015$. English word reading fluency was significantly correlated with English RAN at Time 1, $r_{(38)} = -.727$, $p < .001$.Within language relations at Time 1 were also examined for Chinese variables. Chinese word reading fluency at Time 1 is significantly correlated with Chinese phonological awareness at Time 1, $r_{(38)} = .372$, $p = .018$.

Cross-linguistic relations between Chinese and English variables at Time 1 were examined. Chinese vocabulary at Time 1 was significantly correlated with English vocabulary at Time 1, $r_{(38)} = .452$, $p = .003$, English word reading fluency at Time 1, $r_{(38)} = .351$, $p = .026$, English phonological awareness at Time 1, $r_{(38)} = .425$, $p = .009$. Chinese word reading fluency at Time 1 was significantly correlated with English RAN at Time 1, $r_{(38)} = -.335$, $p = .035$. Chinese phonological awareness at Time 1 was significantly correlated with English RAN at time 1, $r_{(38)} = -.379$, $p = .016$, English phonological awareness at Time 1, $r_{(38)} = .485$, $p = .002$.

Relationships among L1 (Chinese) and L2 (English) variables at Time 2.

Within language relations at Time 2 were examined for English variables. English vocabulary (PPVT) at Time 2 was significantly correlated with English word reading fluency at Time 2, $r_{(30)} = .796$, $p = .002$, English RAN at Time 2, $r_{(30)} = -.499$, $p = .004$. English word reading fluency at Time 2 was significantly correlated with English RAN at Time 2, $r_{(30)} = -.643$, $p < .001$ and English phonological awareness at Time 2, $r_{(30)} = .445$, $p = .011$. English phonological awareness at Time 2 was significantly correlated English RAN at Time 2, $r_{(30)} = -.391$, $p = .027$. Within language relations at Time 2 were also examined for Chinese variables. Chinese vocabulary at Time 1 was significantly correlated with Chinese word reading fluency at Time 2 $r_{(30)} = .665$, $p < .001$. Chinese word reading fluency at Time 2 was significantly correlated Chinese RAN at Time 2 $r_{(30)} = -.413$, $p = .019$.

Cross-linguistic relations between Chinese and English were examined. Chinese phonological awareness at Time 2 was significantly correlated with English word reading fluency a Time 2, $r_{(30)} = .407$, $p = .021$, English RAN at time 2, $r_{(30)} = -.387$, $p = .029$, English phonological awareness at Time 2, $r_{(30)} = .859$, $p < .001$. Chinese word reading fluency at time 2 was negatively correlated with English RAN at Time 2, $r_{(38)} = -.335$, $p = .035$.

Mean Comparisons

Means were compared to examine differences between languages as well as changes over time. Table 4 contains the comparison of scores on each task in English and Chinese. Table 5 contains the comparison of scores on each task at Time 1 and Time 2.

The following sections examine whether English word reading becomes more native-like over time. This is defined by changes in mean scores on the English measures as well as changes in variables related to reading fluency. Due to the relatively large number of statistical tests, we decided to set the significant p-value at $p < .01$.

Time 1 and Time 2 comparisons. English word reading fluency scores were significantly different at Time 1 and Time 2, $t_{(30)} = -5.44$, $p < .001$. Chinese word reading fluency scores were significantly different at Time 1 and Time 2, $t_{(30)} = -3.26$, $p = .003$. English vocabulary scores were significantly different at Time 1 and Time 2, $t_{(30)} = -4.72$, $p < .001$. Chinese vocabulary scores did not differ significantly from Time 1 to Time 2. English RAN scores were significantly different at Time 1 and Time 2, $t_{(30)} = 3.21$, $p = .003$. Chinese RAN scores did not reach statistical significance at Time 1 and Time 2, $t_{(30)} = 2.62$, $p = .014$. English phonological awareness scores were significantly different at Time 1 and Time 2, $t_{(30)} = -6.06$, $p < .001$. Chinese phonological awareness scores were significantly different at Time 1 and Time

2, $t_{(30)} = -3.76$, $p < .001$. The average scores are higher on all measures at Time 2 compared to their counterparts at Time 1 (See Table 5).

Cross-language Comparisons. Visual inspection of average scores on English and Chinese measures showed that the average scores were higher on all Chinese measures compared to their English counterparts, indicating that this group of participants were dominant in their L1 (Chinese) compared to their L2 (English) (See Table 4).

Regression Analyses

To explore significant predictors of oral reading fluency in English and Chinese over two time points, regression analyses were conducted. Given the sample size of 40 at time 1 and 32 at time 2, we have decided to enter a maximum of three variables in the regressions. The results section below helps to address research questions 1 and 2 in detail: 1) Which variables are most highly related to English word reading fluency in Chinese-English speakers? 2) Which variables are most highly related to English text reading fluency in Chinese-English speakers?

a) Which variables at Time 1 will predict English word reading fluency at Time 1?

To explore significant predictors of English word reading fluency at Time 1, one multiple regression analysis was conducted. The following variables were used in this analysis as independent variables: English vocabulary (PPVT), English RAN and English phonological awareness (PigLatin). English word reading fluency was entered as the dependent measure. The total variance explained for English word reading fluency was $R^2 = .870$, $F_{(3, 33)} = 34.38$, $p < .001$. Although, these variables were related to English word reading fluency when entered together, English vocabulary and RAN were the only variables uniquely related to English word reading fluency, $\beta = .390$, $t_{(33)} = 4.18$, $p < .001$ and $\beta = -.621$, $t_{(33)} = -6.869$, $p < .001$,

respectively (See Table 6). Time 1 Chinese variables were not related to Time 1 English word reading fluency (see Appendix A).

b) Which variables at Time 2 will predict English word reading fluency at Time 2?

A multiple regression analysis was conducted to determine if variables at Time 2 (Vocabulary, RAN and phonological awareness) were significant predictors for English word reading fluency at Time 2. English Vocabulary, RAN and phonological awareness at Time 2 were entered as independent variables, and English word reading fluency was entered as the dependent variable. The regression showed that together, English Vocabulary, RAN and phonological awareness at Time 2 significantly predicted English word reading fluency at Time 2, $R^2 = .875$, $F_{(3, 28)} = 30.60$, $p < .001$. Specifically, Time 2 vocabulary was related to word reading fluency, $\beta = .641$, $t_{(28)} = 6.07$, $p < .001$, as was Time 2 phonological awareness, $\beta = .247$, $t_{(33)} = 2.49$, $p = .019$ (See Table 7).

Furthermore, an additional regression was conducted to explore the relationship among Chinese variables and English word reading fluency. Chinese vocabulary, RAN and phonological awareness at Time 2 were entered as independent variables, and English word reading fluency was entered as the dependent variable. The regression showed that together, Chinese vocabulary, RAN and phonological awareness at Time 2 were significantly related to English word reading fluency at Time 2, $R^2 = .504$. Specifically, Time 2 Chinese phonological awareness was related to word reading fluency, $\beta = 2.415$, $t_{(28)} = 2.57$, $p = .016$ (see Table 16).

c) Which variables at Time 2 will predict English text reading fluency at Time 2?

A multiple regression analysis was conducted to determine if variables at Time 2 (vocabulary, RAN and phonological awareness) were significant predictors for English text reading fluency at Time 2. English vocabulary, RAN and phonological awareness at Time 2 were

entered as independent variables, and English text reading fluency was entered as the dependent variable. The regression showed that together, English vocabulary, RAN and phonological awareness at Time 2 significantly predicted English word reading fluency at Time 2, $R^2 = .648$, $F_{(3, 28)} = 6.74$, $p = .001$. However, when looking at the individual coefficients, Time 2 vocabulary was the only significant predictor related to text reading fluency, $\beta = -.742$, $t_{(28)} = -3.58$, $p = .001$ (See Table 8).

To further explore the relationship between word reading fluency and text reading fluency, an additional multiple regression analysis was conducted including Time 2 word reading fluency as an independent variable. As mentioned earlier, due to the small sample size, the regression included a maximum of 3 variables. Therefore, Time 2 word reading fluency, vocabulary and RAN are entered as independent variables, and text reading fluency is entered as dependent variable. The total variance explained for English text reading fluency was $R^2 = .663$, $F_{(3, 28)} = 7.33$, $p = .001$. However, when looking at the individual coefficients, none of the independent variables significantly predicted English text reading fluency at Time 2 (See Table 8).

d) Which variables at Time 1 will predict English word reading fluency at Time 2?

Longitudinal analyses were conducted to determine Time 1 predictors of Time 2 word reading fluency. A multiple regression analysis was conducted to determine if variables at Time 1 are significant predictors for English text reading fluency at Time 2. The following variables were used in this analysis as independent variables: Time 1 English vocabulary, Time 1 English RAN and Time 1 English phonological awareness. Time 2 English word reading fluency was entered as the dependent measure. The total variance explained for English word reading fluency was $R^2 = .802$, $F_{(3, 26)} = 15.63$, $p < .001$. Although, these variables were related to Time 2 English word reading fluency when entered together, Time 1 English vocabulary and RAN were

the only variables uniquely related to Time 2 English word reading fluency, β = .191, $t_{(26)}$ = 4.472, p < .001 and β = -.766, $t_{(26)}$ = -3.76, p = .001, respectively (See Table 9).

e) Which variables at Time 1 will predict English text reading fluency at Time 2?

Longitudinal analyses were conducted to determine Time 1 predictors of Time 2 text reading fluency. A multiple regression analysis was conducted to determine if variables at Time 1 (vocabulary, RAN and phonological awareness) are significant predictors for English text reading fluency at Time 2. English vocabulary, RAN and phonological awareness at Time 1 were entered as independent variables, and English text reading fluency at Time 2 was entered as the dependent variable. The total variance explained for English text reading fluency was R^2 = .705, $F_{(3, 26)}$ = 8.55, p < .001. However, when looking at the individual coefficients, Time 1 vocabulary was the only significant predictor related to text reading fluency, β = -.708, $t_{(26)}$ = -3.91, p = .001. (See Table 10)

To further explore predictors of text reading fluency from Time 1 to Time 2, an additional multiple regression analysis was conducted including Time 1 word reading fluency as an independent variable. Time 1 word reading fluency, vocabulary and RAN are entered as independent variables, and Time 2 text reading fluency is entered as dependent variable. The total variance explained for English text reading fluency was R^2 = .654, $F_{(3, 28)}$ = 6.98, p = .001. Specifically, Time 1 vocabulary was still the only significant predictor related to Time 2 text reading fluency, β = -.605, $t_{(28)}$ = -2.79, p = .009. (See Table 11)

4). Does the level of motivation and acculturation to Canadian culture predict literacy skills in English in older Chinese-English bilingual adolescents?

The questions from the acculturation questionnaire were divided into the mainstream acculturation subscale and the heritage enculturation subscale. Overall, participants had an

average score of 3.98 (SD = .37) on the heritage scale, and an average score of 3.31 (SD = .47) on the mainstream scale. To further explore the relationship between the mainstream acculturation subscale and heritage enculturation subscale, a paired samples t-test was conducted. Although mean scores fell above the midpoint of the scale reflecting positive endorsement, the results indicate that participants identified themselves more with the enculturation with their heritage culture than acculturation in mainstream culture t (31) = 5.99, p < .001 (See Table 19).

Correlation analyses showed that the mainstream acculturation score was significantly correlated with English vocabulary $r_{(31)}$ = .716, p < .001, English word reading fluency (number of words correct) $r_{(31)}$ = .643, p < .001. As expected, it was negatively correlated with English RAN $r_{(31)}$ = - 590, p < .001. However, the heritage enculturation score was only significantly related to English RAN $r_{(31)}$ = .443, p = .011, with higher heritage enculturation scores related to more time spent on RAN in English (See Table 20).

To explore the relationship between acculturation scores and English word reading fluency at Time 2, a multiple regression analysis was conducted. The following variables were used in this analysis as independent variables: mainstream acculturation score, English vocabulary and English phonological awareness. Time 2 English word reading fluency was entered as the dependent measure. The total variance explained for English word reading fluency was R^2 = .747, $F_{(3,31)}$ = 27.50, p < .001. Although, these variables were related to English word reading fluency when entered together, English vocabulary and phonological awareness were the only variables uniquely related to English word reading fluency, β = .229, $t_{(31)}$ = 4.50, p < .001 and β = 1.20, $t_{(31)}$ = 3.35, p = .002, respectively (See Table 21). Mainstream acculturation did not contribute to any unique variance to word reading fluency.

Additional exploratory analyses were conducted to try to understand the relationship between acculturation and word reading. Correlation analyses was conducted to examine whether the acculturation score had an indirect effect on English word reading. Results indicated that all the pathways between English vocabulary $\beta = .742$, $t_{(31)} = 7.61$, $p < .001$, phonological awareness $\beta = .319$, $t_{(31)} = 3.72$, $p < .003$, and English word reading (See Table 21), mainstream acculturation $\beta = 12.65$, $t_{(31)} = 4.59$, $p < .001$, and English word reading (See Table 22), English vocabulary $\beta = .013$, $t_{(31)} = 5.61$, $p < .001$, phonological awareness *and* mainstream acculturation were significant, (See Table 23). Multiple regression with both English vocabulary, phonological awareness and mainstream acculturation predicting English word reading indicated that mainstream acculturation did not show any mediation effect $\beta = 2.95$, $t_{(31)} = .95$, $p = .351$ (See Table 24).

Discussion

The present study examined the development of L2 (English) reading skills in adolescent Chinese-English readers, who were recent immigrants to Canada. This group of participants represents late sequential bilinguals enrolled in post-secondary education in their L2. Unlike children who are exposed to their L2 at an earlier age, our participants began to learn their L2 (English) in middle school or later. Some of their L2 learning occurred in a foreign language setting and some occurred in an immersion setting where English was the societal language. A large body of recent research in the field of second language learning and literacy development has focused on younger children who are exposed to their L2 at an early age. However, only a few studies have examined L2 word reading development in adolescents or young adults, who are introduced to their L2 in middle school or later.

Participants were tested in both English and Chinese on measures of word reading fluency and accuracy, text reading fluency, vocabulary knowledge, rapid digit naming, and phonological awareness. The research examined if and how English word reading becomes more automatic (fluent) over time in adolescents who speak Chinese as their first language. In addition, the study accounted for the potential for variables such as vocabulary knowledge and phonological awareness that may be related to reading fluency. Given that previous research has generated mixed results on cross language transfer of oral reading and its related strategies (Fuchs, Fuchs, Hosp & Jenkins, 2001; Pasquarella, Chen, Gottardo & Geva, 2014), our main interest was to further examine the development of oral reading in Chinese-English bilinguals. In addition to linguistic skills related to word reading in the L2, this study examined whether the level of motivation and acculturation to Canadian society predicted literacy skills in English in older Chinese-English bilingual adolescents.

Word reading fluency

First we examined which English variables from Time 1 were associated with word reading fluency in English at Time 1. We found that together, English vocabulary knowledge, RAN and phonological awareness explained a large amount of variance in English word reading fluency at Time 1. Furthermore, when variables were examined individually, only vocabulary and RAN were significant predictors of word reading accuracy in English. This result adds to existing body of research demonstrating the importance of vocabulary and RAN in relation to word reading (Vocabulary; Wang et al, 2009; RAN; McIlraith, 2018; Mcbride-Chang et al., 2013). However, contrary to our hypothesis, English phonological awareness was not a statistically significant predictor of word reading fluency in English. This finding may be due to the fact that English and Chinese differ substantially in their writing systems. As supported by

the Psycholinguistic Grain Size theory, learners of different languages will develop different processes to deal with grain size, which will affect the acquisition of written language (Goswami, Ziegler & Richardson, 2005). Compared to English, Chinese lacks the sound-letter correspondences in its written language. Therefore, character reading in Chinese uses different strategies compared to word reading in English (Goswami, 2008). Although a large body of past research has found evidence of cross-language transfer of phonological awareness skills in Chinese-English bilingual children (Gottardo, Yan, Siegel & Wade-Woolley, 2001; Lin, Cheng & Wang, 2017; Morais, 1991), the majority of participants investigated in the studies were younger children who learn their L2 at an earlier age. Children who learn an alphabetic language such as English develop awareness of phonemes at an early age, whereas children who learn a character based language such as Chinese do not seem to develop such pattern (Gottardo, Chiappe, Yan, Siegel & Gu, 2006). Given that all of our participants have received their education in China up until Grade 12 and were introduced to English in middle school or later, linguistic patterns and skills in their L1 (Chinese) have much stronger influences on them compared to younger Chinese-English bilinguals. Therefore, phonological awareness was not related to English word reading fluency in Chinese-English bilinguals who are recent immigrants to Canada. Extant research on older L2 learners has illustrated similar patterns, where phonological awareness was not significantly related to English word reading in older Chinese-English bilinguals (Gottardo, Koh, Chen & Jia, 2017; Li, Tao, Joshi & Xu, 2017). Findings were consistent when Time 1 variables were explored to determine significant predictors of Time 2 word reading fluency. Time 1 English vocabulary and RAN were unique predictors of Time 2 word reading fluency.

After participants were tested again on the same measures one year later at Time 2, an additional regression analysis was performed to investigate if Time 2 vocabulary knowledge, RAN and phonological awareness demonstrate the same pattern in relation to word reading at Time 2. Most of the findings were replicated from the analysis above. Surprisingly, in addition to English vocabulary, English phonological awareness at Time 2 was a unique predictor of English word reading at Time 2. Unlike Time 1 where phonological awareness did not predict word reading fluency, the relationship between Time 2 phonological awareness and word reading suggested that English word reading is becoming more native-like over time in our Chinese-English bilingual participants. As mentioned earlier, a large body of previous research has found phonological awareness to be a strong predictor of word reading in an alphabetic language (Linan-Thompson, Vauhn, Prater & Cirino, 2006; Lesaux & Siegel, 2003). In addition, cross-language transfer of phonological awareness occurs at a more abstract level, involving metalinguistic skills when L1 and L2 are linguistically distant from one the other (Kuo & Anderson, 2007). The relationship between phonological awareness and word reading fluency at Time 2 and the gains in English and Chinese phonological awareness suggest that over the one-year period, these Chinese-English bilingual adolescents and young adults have acquired greater awareness of phonemes in English, and therefore were able to use linguistic skills such as phonological awareness to support English word reading.

Interestingly, Chinese phonological awareness at Time 2 also significantly predicted English word reading fluency. This finding supports previous research on the bidirectionality of cross-language transfer of linguistic skills between L1 and L2. As suggested by Cook (2003), the acquisition of the L2 can influence the L1 in skilled readers. Having Chinese phonological awareness as a unique predictor of English word reading fluency, the findings from this study

extended Jared and Kroll's (2001) research on cross-language transfer of phonological awareness, suggesting the possibility of cross-language transfer of spelling-to-sound correspondences from the L2 (English) to the L1 (Chinese) even when the two languages differ in their writing systems. As mentioned earlier, this group of late sequential Chinese-English bilinguals acquired their L2 in a foreign language setting, where English is taught using a "look-say" approach. Due to the lack of sound-letter correspondences in Chinese and the medium of instruction for learning English, phonological awareness was a weak variable in this group of participants at the beginning of the study. However, both English and Chinese phonological awareness significantly predicted English word reading fluency at Time 2, suggesting improvement on the skill of phonological awareness. It is possible that through out the one-year period of time, our participants had gained knowledge of phonological awareness through intensive exposure to written English, and consequently improved their phonological awareness skill in their L1. Therefore, phonological awareness skills in both languages acted as unique predictors to English word reading fluency when they were tested at Time 2.

Text reading fluency

In addition to English word reading fluency, English text reading fluency was included as an additional measure at Time 2 as an indicator of higher level processing and language competence in L2. Past research suggested that text reading fluency is an indication of higher level language skills including vocabulary and deeper comprehension for skilled readers (Wolf & Katzir-Cohen, 2001). Geva, Wade-Wooley and Shany (1997) suggested that when L2 learners achieve a certain level of language proficiency, text reading fluency and language skills are positively related to one the other. Therefore, while word reading fluency might be a better predictor of reading comprehension for beginner L2 learners, text reading fluency may be better

at predicting reading comprehension in more proficient L2 learners (Geva & Farnia, 2012; Jenkins et al, 2000). Visual inspection of the scores on English measures from Time 1 showed various levels of competence in English. Although all of the participants were recent immigrants and/or international students who had been in Canada for less than two years, they demonstrated diverse performance on English tasks with some performing significantly better than others. Therefore, in order to ensure that we have adequate measures for participants at all levels, English text reading fluency was included as an additional measure at Time 2.

With respect to text reading fluency, we found that Time 1 English vocabulary, RAN and phonological awareness explained a large amount of variance in relation to text reading fluency at Time 2. When variables were looked at individually, only Time 1 English vocabulary uniquely predicted text reading fluency at Time 2. To further explore if other variables were significant predictors of text reading fluency, we are also interested in seeing if word reading fluency and accuracy would predict text reading fluency from Time 1 to Time 2. Similar results were generated from regression analyses, where Time 1 English vocabulary was the only significant predictor of Time 2 text reading fluency.

Consistent with previous research, this finding suggested that vocabulary plays an important role in L2 acquisition in older L2 learners (Gottardo, Koh, Chen & Jia, 2017). Vocabulary knowledge includes two dimensions, breadth and depth (Ouellette, 2006). Specifically, vocabulary breadth has been found to be more highly related to oral reading fluency (Cain & Oakhill, 2014). Although a large body of previous research on L2 learning that focused on younger children treated vocabulary as a control variable (Tong, McBride-Chang, Ho, Waye & Chung, 2017; Tong, Tong & McBride-Chang, 2017), we believe it was essential to explore the importance of vocabulary in relation to oral reading fluency with older L2 learners. Previous

studies conducted in North America have found that English vocabulary breadth contributed a large amount of variance in English word reading among Chinese-English adolescents and adults (Wang et al., 2006; Gottardo, et al., 2017). Therefore, our finding from the current study adds to existing research emphasizing that Time 1 English vocabulary was the only unique predictor for English text reading fluency at Time 2. The same regression analyses were conducted using Time 2 variables to predict Time 2 text reading fluency. Similar results were generated. In line with previous analyses, English vocabulary was the only unique predictor of Time 2 text reading fluency when entered together with RAN and phonological awareness. However, none of the variables were significant when Time 2 word reading fluency and word reading accuracy were added as autoregressors.

Cross-language transfer between L1 and L2

Chinese variables related to oral reading fluency were examined in other analyses on Chinese-English bilinguals to determine within and cross-linguistic predictors of word reading in Chinese. However, none of the variables were significant predictors of Chinese and English word and text reading fluency at both time points. One of the explanations for the nonsignificant result could be the ceiling effect for the Chinese tasks. From visual inspection of the raw data, participants had achieved very high or close to ceiling scores on majority of the Chinese tasks, especially on Chinese RAN and phonological awareness. With majority of the key variables reaching close to ceiling results in Chinese, it is not surprising that the analyses did not generate any statistically significant results.

Does English word reading become more native-like over time?

In order to address whether English word reading become more native like over time, changes in each measure at Time 1 and Time 2 were compared over the one-year period. We

found that on average, participants performed significantly better on all of the English measures at Time 2 compared to Time 1. This finding suggested that through the one-year period of time, these late-sequential L2 learners had improved on all aspects of their English skills, including vocabulary, RAN, phonological awareness and word reading. The same analysis was conducted for Chinese tasks as a comparison. The results showed that not all Chinese tasks were significantly different from Time 1 to Time 2. Scores on Chinese vocabulary remained the same at both time points. This outcome suggests that the improvements observed in English tasks were not merely a practice effect in terms of the measures nor consistent developmental gains, given that participants were performing significantly better on all of English skills measured when tested one year later.

In addition, as mentioned above, Time 2 phonological awareness in both English and Chinese were unique predictors of English word reading at Time 2, unlike Time 1 where phonological awareness was not related. The finding between Time 2 phonological awareness and word reading suggested that English word reading was becoming more native-like over time in our Chinese-English bilingual participants. The significant relationship between phonological awareness and word reading at Time 2 showed that over the one-year period of learning English as an L2, our participants had higher scores on tasks that measure awareness of phonemes in both English and Chinese. As a result they were able to use this linguistic skill to complete phonological awareness tasks. Using this skill was related to English word reading.

4) Does the level of motivation and acculturation to Canadian culture predict literacy skills in English in older Chinese-English bilingual adolescents?

Correlational analyses showed that the level of acculturation to mainstream culture was significantly related to some key L2 language skills such as vocabulary, word reading fluency

and RAN. As proposed by previous research, motivation is a key factor related to the acquisition and development of L2 (Schumann, 1986; Masgoret & Gardner, 1999). In our current study, higher scores on the mainstream acculturation questionnaire indicated higher levels of engagement and interaction with the mainstream (Canadian) culture. As proposed by Gardner's socioeducational model, individuals' willingness to acquire their L2 is related to their attitude toward the mainstream culture through increased interactions with the mainstream language community (Gardner, 1985). Therefore, the positive correlation between mainstream acculturation and L2 language skills suggested that participants who are more motivated to engage in their new mainstream culture are also more likely to succeed in acquiring L2. However, multiple regression analyses did not find a mediation effect of acculturation between L2 vocabulary and L2 word reading. Unlike previous research conducted by Jia and colleagues (2014) that found the level of acculturation to Canadian culture predicted literacy skills in English among adolescent Chinese immigrants, the results from the current study did not demonstrate such effect. This finding can be explained by the fact that our participants were recent immigrants or international students who have just started university in Canada. The effect of level of acculturation to mainstream culture might increase with time. Therefore, the results might demonstrate different patterns if these participants are tested again for Time 3 (24 months apart from Time 1) or Time 4 (36 months apart from Time 1).

Limitations and future directions

The present study had some limitations, most notably sample size. This research project had a fairly small sample size because there were challenges recruiting participants that satisfied all requirements for this project in the Kitchener-Waterloo region (N=40). In addition, this project had a fairly high attrition rate. Over the course of one year, a total of 20% of participants

(8 students) dropped out from the project (3 students moved to Vancouver, 1 student moved back to China, 3 students declined to participate at Time 2). To address this limitation, regression analyses in the present study were conducted with fewer variables to accommodate the smaller sample.

In addition, scores on the majority of the Chinese tasks were very high or almost at ceiling. This is due to the lack of experimental measures available for participants of this group. Given that all of the participants have received high school level education in China, Chinese measures needed to match this level of difficulty. However, creating experimental measures is not without challenges. With very little previous work conducted on this age group, there were very few established Chinese measurements adequate for their level of difficulty. The present study introduced some novel measures that can be revised going forward. In addition, the present study allows discrimination among stronger and weaker measures in this sample, which provided information regarding challenges needed going forward.

Conclusion

Overall, the findings of this research were generally consistent with previous theories and research. There are significant improvements on all of the English measures over the one-year period among our sample of adolescent Chinese-English bilingual participants. Contrary to our hypotheses, vocabulary was more predictive of English word and text reading fluency compared to other skills, particularly at Time 1. Phonological awareness at Time 2 in both L1 and L2 were significantly related to English word reading. Also, although the level of acculturation to mainstream culture was significantly related to L2 language skills such as vocabulary, word reading and RAN, it was not a unique predictor of reading fluency. This group of late-sequential

Chinese-English bilinguals demonstrated different profiles compared to younger bilingual learners in the literature.

In conclusion, English vocabulary consistently predicted English word and text reading fluency at both Time 1 and Time 2. This adds to existing research conducted in North America on the importance of vocabulary knowledge in sequential Chinese-English bilinguals (Gottardo, Koh, Chen & Jia, 2017; Wang et al., 2006). Phonological awareness, on the other hand, was a unique predictor of English word reading at Time 2 but not Time 1. This finding is consistent with the Psycholinguistic Grain Size theory that initially, people who speak Chinese as their L1 do not develop strong awareness at the level of phonemes due to the lack of sound-letter correspondences in the Chinese language (Goswami, Ziegler & Richardson, 2005; Gottardo, Chiappe, Yan, Siegel & Gu, 2006). However, through the one-year intensive exposure to English as an L2, this group of late sequential Chinese-English bilingual participants had gained knowledge about phonological awareness, and consequently improved their phonological awareness skills in their L1. This finding supports Cook's theory that the acquisition of the L2 can influence the L1 in skilled readers (Cook, 2003). The findings from this study not only add to Jared and Kroll (2001)'s research on the phonological awareness activation in English-French bilinguals, they also show the effects of L2 language skills on the L1 when the L1 is a character-based language.

Overall, this research project conducted on sequential Chinese-English bilingual who are recent immigrants to Canada is important for understanding the patterns of second language reading acquisition in Chinese-English speakers. With the large number of international students and the immigrant population in Canada, the findings from this study have advanced our understanding of acquisition in L2. The outcome of this study can be used to inform future

research, especially with regard to test measure development. The present study also contributed to our understanding of language acquisition in late sequential, Chinese-English bilinguals, which may be an important consideration for successful educational policies and practices.

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Table 1: *Descriptive Statistics for age and Time 1 and Time 2 measures*

	N	Mean	Std. Deviation
Age	40	20.39	3.55
Years in Canada	40	1.57	1.01
Age at Time 2	32	20.67	3.82
T1 English vocabulary	40	125.58	25.10
T1 English word reading	40	78.90	9.54
T1 English RAN	40	31.34	6.40
T1 English phonological awareness	37	19.97	3.91
T1 Chinese word reading	40	95.78	11.12
T1 Chinese phonological awareness	40	11.90	2.13
T1 Chinese RAN	40	20.23	3.91
T1 Chinese vocabulary	40	216.28	11.60
T2 English text reading fluency	32	71.50	31.12
T2 English vocabulary	32	137.69	24.98
T2 English word reading fluency	32	85.75	9.23
T2 English RAN	32	28.25	5.92
T2 English phonological awareness	32	24.28	2.50
T2 Chinese word reading fluency	32	101.53	4.52
T2 Chinese RAN	32	18.27	2.26
T2 Chinese phonological awareness	32	13.41	1.62
T2 Chinese vocabulary	32	220.40	8.60

T1, Time 1; T2, Time 2

Table 2: *Time 1 Correlational matrix for all English and Chinese measures*

	1.EV	2.CV	3.EWR	4.CWR	5.ERAN	6.CRAN	7.EPA	8. CPA
1. English vocabulary	1							
2. Chinese vocabulary	**.452****	1						
3. English word reading fluency	**.628****	**.351***	1					
4. Chinese word reading fluency	.090	.040	.294	1				
5. English RAN	**-.383***	-.090	**-.727****	**-.335***	1			
6. Chinese RAN	.148	-.066	.023	.215	-.133	1		
7. English phonological awareness	.256	**.425****	.294	.298	-.076	.149	1	
8. Chinese phonological awareness	.130	.233	.206	**.372***	**-.379***	.254	**.485****	1

** Correlation is significant at the .01 level (2 tailed).

* Correlation is significant at the .05 level (2 tailed).

EV, English vocabulary; CV, Chinese vocabulary; EWR, English word reading fluency; CWR, Chinese word reading fluency; ERAN, English RAN; CRAN, Chinese RAN; EPA, English phonological awareness; CPA, Chinese phonological awareness

Table 3: *Time 2 Correlational matrix for all English and Chinese measures*

	1.EV	2.CV	3.EWR	4.CWR	5.ERAN	6.CRAN	7.EPA	8. CPA
1. English vocabulary	1							
2. Chinese vocabulary	-.156	1						
3. English word reading fluency	**.796****	-.147	1					
4. Chinese word reading fluency	-.159	**.665****	.054	1				
5. English RAN	**-.499****	.249	**-.643****	.083	1			
6. Chinese RAN	.012	-.206	-.202	**-.413***	.297	1		
7. English phonological awareness	.204	.140	**.407***	.229	**-.387***	-.081	1	
8. Chinese phonological awareness	.171	.095	**.445***	.257	**-.391***	-.183	**.859****	1

** Correlation is significant at the .01 level (2 tailed).
* Correlation is significant at the .05 level (2 tailed).

EV, English vocabulary; CV, Chinese vocabulary; EWR, English word reading fluency; CWR, Chinese word reading fluency; ERAN, English RAN; CRAN, Chinese RAN; EPA, English phonological awareness; CPA, Chinese phonological awareness

Table 4: *Means and standard deviations for parallel English and Chinese variables*

Variables	English	Chinese
T1 Word Reading Fluency (R)	78.90 (9.55)	95.78 (11.12)
T1 Vocabulary (PC)	.55 (.11)	.90 (.05)
T1 RAN (R)	31.34 (6.35)	20.23 (3.91)
T1 Phonological Awareness (PC)	.77 (.15)	.86 (.13)
T2 Word Reading Fluency (R)	85.75 (9.23)	101.53 (4.52)
T2 Vocabulary (PC)	.60 (.11)	.92 (.04)
T2 RAN	28.25 (5.91)	18.21 (2.26)
T2 Phonological Awareness (PC)	.93 (.10)	.96 (.12)

T1, Time 1; T2, Time 2; R, raw score; PC, percent correct score

Table 5: *Comparisons between Time 1 and Time 2 variables*

Variables	Time 1	Time 2	t-value & Sig.
ENG Word Reading Fluency (R)	78.90 (9.55)	85.75 (9.23)	-5.44**
CHN Word Reading Fluency (R)	96.09 (10.10)	101.53 (4.52)	-3.26**
ENG Vocabulary (PC)	.55.00 (.11)	.60 (.11)	-4.72**
CHN Vocabulary (PC)	.90 (.05)	.92 (.04)	-1.63
ENG RAN (R)	30.94 (6.30)	28.24 (5.92)	3.21**
CHN RAN (R)	20.14 (3.24)	18.27 (2.26)	2.62*
ENG Phonological Awareness (PC)	.78 (.14)	.94 (.09)	-6.06**
CHN Phonological Awareness (PC)	.85 (.16)	.96 (.12)	-3.76**

ENG, English; CHN, Chinese; R, raw score; PC, percent correct score

Table 6: *Time 1 English variables related to Time 1 English word reading fluency (R^2=.87)*

Variables	β	t-value	Sig.
T1 PPVT	.390	4.18**	.000
T1 RAN	-.621	-6.87**	.000
T1 PA	.148	1.67	.105

T1 PPVT, Time 1 English vocabulary; T1 RAN, Time 1 English RAN; T1 PA, Time 1 English phonological awareness

Table 7: *Time 2 English variables related to Time 2 English word reading fluency (R^2=.88)*

Variables	**β**	**t-value**	**Sig.**
T2 PPVT	.641	6.08**	**.000**
T2 RAN	-.227	-2.01	.054
T2 PA	.247	2.49*	**.019**

T2 PPVT, Time 2 English vocabulary; T2 RAN, Time 2 English RAN; T2 PA, Time 2 English phonological awareness

Table 8: *Time 2 English variables related to Time 2 English text reading fluency (Model 1, R^2=.71; Model 2, R^2=.66)*

	Variables	β	t-value	Sig.
Model 1	T2 PPVT	-.596	-3.58**	.001
	T2 RAN	.121	.681	.501
	T2 PA	.143	.913	.369
Model 2	T2 WRF	-.365	-1.38	.179

T2 PPVT, Time 2 English vocabulary; T2 RAN, Time 2 English RAN; T2 PA, Time 2 English phonological awareness; T2 WRF, Time 2 English word reading fluency

Table 9: *Time 1 English variables related to Time 2 English word reading fluency (R^2=.80)*

Variables	β	t-value	Sig.
T1 PPVT	.547	4.47**	.000
T1 RAN	-.458	-3.76**	.001
T1 PA	.012	.11	.917

T1 PPVT, Time 1 English vocabulary; T1 RAN, Time 1 English RAN; T1 PA, Time 1 English phonological awareness

Table 10: *Time 1 English variables related to Time 2 English text reading fluency (Model 1, R^2=.65; Model 2, R^2=.65)*

	Variables	β	t-value	Sig.
Model 1	T1 PPVT	-.568	-3.91**	.001
	T1 RAN	.284	1.97	.060
	T1 PA	.159	1.13	.268
Model 2	T1 WRF	-.495	-.50	.625

T1 PPVT, Time 1 English vocabulary; T1 RAN, Time 1 English RAN; T1 PA, Time 1 English phonological awareness; T1 WRF, Time 1 English word reading fluency

Table 11: *Time 1 Chinese variables related to Time 1 Chinese word reading fluency (R^2=.396)*

Variables	β	t-value	Sig.
T1 C-PPVT	-.024	-.15	.879
T1 C-RAN	.376	.83	.414
T1 C-PA	.801	2.11*	.042

T1 C-PPVT, Time 1 Chinese vocabulary; T1 C-RAN, Time 1 Chinese RAN; T1 C-PA, Time 1 Chinese phonological awareness

Table 12: *Time 1 Chinese variables related to Time 2 Chinese word reading fluency (R^2=.119)*

Variables	β	t-value	Sig.
T1 C-PPVT	-.039	-.504	.618
T1 C-RAN	.004	.014	.989
T1 C-PA	-.085	-.212	.834

T1 C-PPVT, Time 1 Chinese vocabulary; T1 C-RAN, Time 1 Chinese RAN; T1 C-PA, Time 1 Chinese phonological awareness

Table 13: *Time 2 Chinese variables related to Time 2 Chinese word reading fluency (R^2=.732)*

Variables	β	t-value	Sig.
T2 C-PPVT	.310	4.446**	.000
T2 C-RAN	-.565	-2.142	.041
T2 C-PA	.344	.948	.351

T2 C-PPVT, Time 2 Chinese vocabulary; T2 C-RAN, Time 2 Chinese RAN: T2 C-PA, Time 2 Chinese phonological awareness

Table 14: *Time 1 Chinese variables related to Time 1 English word reading fluency (R^2=.374)*

Variables	β	t-value	Sig.
T1 C-PPVT	.266	1.99	.053
T1 C-RAN	.040	.101	.920
T1 C-PA	.567	.766	.448

T1 C-PPVT, Time 1 Chinese vocabulary; T1 C-RAN, Time 1 Chinese RAN; T1 C-PA, Time 1 Chinese phonological awareness

Table 15: *Time 1 Chinese variables related to Time 2 English word reading fluency (R^2=.303)*

Variables	β	t-value	Sig.
T1 C-PPVT	.130	.863	.395
T1 C-RAN	-.326	-.585	.563
T1 C-PA	.750	.957	.347

T1 C-PPVT, Time 1 Chinese vocabulary; T1 C-RAN, Time 1 Chinese RAN; T1 C-PA, Time 1 Chinese phonological awareness

Table 16: *Time 2 Chinese variables related to Time 2 English word reading fluency (R^2=.504)*

Variables	β	t-value	Sig.
T2 C-PPVT	-.270	-1.498	.145
T2 C-RAN	-.897	-1.313	.200
T2 C-PA	2.415	2.574*	.016

T2 C-PPVT, Time 2 Chinese vocabulary; T2 C-RAN, Time 2 Chinese RAN; T2 C-PA, Time 2 Chinese phonological awareness

Table 17: *Correlational matrix comparing oral reading accuracy to fluency*

	1.	2.	3.	4.	5.	6.
1. English word ID	1					
2. English word attack	**.752****	1				
3. English word reading fluency	**.763****	**.761****	1			
4. English pseudoword reading fluency	**.753****	**.766****	**.814****	1		
5. Chinese word reading fluency	.157	.384	.294	.220	1	
6. Chinese text reading fluency	-.029	-.238	-.236	-.170	-.139	1

Table 18: *Mean comparison regarding attrition from Time 1 to Time 2*

	Group1				Group2			
	Mean	SD	Min	Max	Mean	SD	Min	Max
English vocabulary	125.78	25.76	67	184	124.75	23.90	85	150
English word reading fluency	79.44	9.55	63	102	76.75	9.81	61	90
English PA	20.37	3.70	12	26	18.29	4.61	13	26

Group 1, Participants who participated at both time 1 and 2; Group 2: Participants who dropped out at time 2

Table 19: *Comparisons between mainstream acculturation subscale and heritage enculturation subscale*

	Mainstream acculturation subscale	Heritage enculturation subscale	t-value & Sig.
Acculturation Questionnaire	3.31 (.47)	3.98 (.37)	5.99**

Table 20: *Correlational matrix comparing acculturation scores to English variables*

	E_TRF	E_PPVT	E_WRF	E_RAN	E_PA	1.	2.
1. Mainstream acculturation	-.349	.716**	.643**	-.590**	.092	1	-.107
2. Heritage enculturation	.338	-.197	-.218	.433**	.009	-.107	1

** Correlation is significant at the .01 level (2 tailed).
* Correlation is significant at the .05 level (2 tailed).

E_TRF, English text reading fluency; E_PPVT, English vocabulary; E_WRF, English word reading fluency; E_RAN, English RAN; E_PA, English phonological awareness

Table 21: *Time 2 English vocabulary and phonological awareness related to Time 2 English word reading fluency (R^2=.86)*

Variables	β	t-value	Sig.
T2 E_PPVT	.742	7.61**	.000
T2 E_PA	.319	3.72**	.003

T2 E-PPVT, Time 1 English vocabulary; T2 E_PA, Time 1 English phonological awareness

Table 22: *Time 2 mainstream acculturation score related to Time 2 English word reading fluency (R^2=.643)*

Variables	β	t-value	Sig.
Acculturation	.643	4.60**	.000

Table 23: *Time 2 English vocabulary and phonological awareness related to mainstream acculturation score (R^2=.716)*

Variables	β	t-value	Sig.
T2 E_PPVT	.721	5.48**	.000
T2 E_PA	-.031	-2.33	.817

T2 E-PPVT, Time 1 English vocabulary; T2 E_PA, Time 1 English phonological awareness

Table 24: *Time 2 English vocabulary, phonological awareness and acculturation related to Time 2 English word reading fluency (R^2=.803)*

Variables	β	t-value	Sig.
T2 E_PPVT	.619	4.49**	.000
T2 E_PA	.324	3.35	.002
Acculturation	.170	1.24	.351

T2 E-PPVT, Time 1 English vocabulary; T2 E_PA, Time 1 English phonological awareness