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Early Predictors of Biliteracy Development in Children in French Immersion: A 4-Year Longitudinal Study

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English language predictors of English and French reading development were investigated in a group of 140 children who were enrolled in French immersion programs. Children were first tested in kindergarten, and their reading achievement was tested yearly in both English and French from Grades 1 to 3, with word-level and passage-level measures that assessed accuracy as well as fluency. Hierarchical linear modeling was used to examine which English variables predicted Grade 3 outcomes and growth rates in English and French, and to determine the set of predictors that accounted for the most variance in outcomes and growth rates in English and French reading. The variables that predicted English reading development were consistent with studies of monolingual English children, even though participants were concurrently learning to read in French. Our findings provide evidence that at least some of the skills that play a role in learning to read are general cognitive and linguistic skills that transfer across languages. Phonological awareness, letter-sound knowledge, rapid automatized naming, and grammatical ability in English were able to predict reading ability in French. In contrast, English receptive vocabulary was a language-specific predictor. These findings demonstrate that first-language measures can be useful in the early identification of children at risk for difficulty in learning to read in a second language.

Keywords: biliteracy, predictors of reading, cross-language predictors, early identification, French immersion

Many children around the world learn at school to read and write in a language other than the one they speak at home. These children provide a challenge to their teachers, particularly if they struggle to learn to read. It can be difficult to determine whether their problems arise from lack of experience with the language of

instruction, impairment in basic processes needed to learn to read, or both (Durgunoğlu, 2002). Sound empirical support is needed, therefore, for measures that can identify young children who are at risk for reading failure before they begin to learn the language of the school or while their proficiency in that language is still developing.

Mounting evidence from studies of monolingual English children indicates that early progress in learning to read depends critically on oral language skills (e.g., Bowey, 2005; Muter, Hulme, Snowling, & Stevenson, 2004). An obvious question for children who are learning to read in a language that is new to them is whether progress in learning to read in that language can be predicted by their native oral language skills. This question raises an interesting theoretical issue concerning the language specificity of the skills that are involved in learning to read. That is, are the skills that play a role in learning to read in a particular language specific to that language, or are they more general linguistic or cognitive skills? If general cognitive and linguistic skills play a strong role in learning to read in a first language, then one might expect that they would also do a good job at predicting reading ability in a second language. Alternatively, if literacy development depends on knowledge of the specific linguistic forms and orthographic principles of the language, then one might expect that skills assessed in a first language would do a poor job at predicting reading development in a second language. Geva and Wade-Woolley (1998) suggested that both types of knowledge and skills contribute to the development of reading proficiency. However, it

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is not entirely clear which of the cognitive tests that are related to individual differences in reading development in monolinguals are language specific and which assess more general language and cognitive skills. Some may assess both. For example, a vocabulary test may assess breadth of knowledge of vocabulary in a particular language, but at the same time it might also give an indication of a more general ability to acquire new words. Tests of working memory, such as pseudoword repetition, appear at first glance to assess a general cognitive skill, but there is evidence that pseudoword repetition is influenced by knowledge of the language from which the pseudowords were derived (Gathercole, 1995; Thorn & Gathercole, 1999). Furthermore, predictors of reading development may differ depending on how reading ability is assessed. It is possible, for example, that predictors of word identification are more general cognitive and linguistic skills, which readily predict reading across languages, whereas predictors of reading comprehension are language specific.

A prominent view of second-language learning suggests that children's native oral language skills should predict their ability to read in their second language. Cummins's (1978, 1980, 1984) developmental interdependence hypothesis claims that competence in a second language is dependent upon the developmental level of the child's native language at the time when intensive exposure to the second language begins. When the first language is poorly developed, particularly with respect to the decontextualized language used in books, intensive exposure to the second language can impede further development of the first language, and this in turn limits the development of the second language. This view predicts a strong correlation across languages for academic language ability, and that these skills in a bilingual's first language should be similarly predictive of first- and second-language reading ability (see Cummins, 1991, for a review of evidence supporting this position). Similarly, Guglielmi (2008) articulated a model describing the pathways through which the bilingual education of limited-English-proficiency students affects long-term academic and occupational outcomes. These outcomes are assumed to be a function of earlier academic achievement, which depends heavily on students' English literacy abilities. In turn, English literacy skills are assumed to be predicted by native language proficiency. However, Verhoeven (1994) pointed out that language proficiency needs to be more precisely specified in theories of second-language learning because not all first-language skills might transfer to the second language. He provided evidence that there is interdependence in the development of phonological and pragmatic language skills across languages but that the development of lexical and morphosyntactic skills in first and second languages are autonomous processes. If this is indeed the case, then first-language vocabulary and grammatical skills may be unrelated to second-language reading ability.

The extent to which children's native oral language skills predict their ability to read in their second language likely depends on the linguistic characteristics of their native and new language. A variable on which alphabetic languages differ that is relevant for learning to read is in the transparency of their letter-sound correspondences (Seymour, Aro, & Erskine, 2003). Share (2008) argued that although phonological awareness is important for learning to read in all alphabetic orthographies, the extreme degree of nontransparency in English has exaggerated the importance of phonological awareness for learning to read in more transparent

alphabets. In most studies of reading development in second-language learners, the children's second language is English (see August & Shanahan, 2006, for a review), and therefore the relationship between first-language phonological awareness and second-language literacy acquisition may be greater in those studies than will be observed for children whose second language contains more consistent spelling-sound correspondences. Because the children in the present study were learning to read simultaneously in English and French, we could compare the strength of phonological awareness and other predictors of reading development in languages that differ in transparency without the problems inherent in testing children from two cultures and education systems (e.g., Patel, Snowling, & de Jong, 2004). Languages differ on other dimensions as well, which may have implications for predictors of reading ability. For example, there is some evidence that the syllable is a more basic unit than the phoneme for beginning French readers. Bruck, Genesee, and Caravolas (1997) gave kindergarten children eight phonological awareness tasks designed to assess syllable, onset-rime, and phoneme levels of awareness and found that the best predictor of French-speaking children's word reading ability in Grade 1 was a syllable awareness task, whereas onset-rime awareness tasks were significant predictors for English-speaking children.

The sociopolitical context of second-language learning affects a variety of variables that are related to literacy acquisition, such as the amount of exposure to both the new and the native language, but at this point we do not know whether learning context has an influence on early predictors of reading development. The Spanish-English bilingual children in most of the recent North American studies investigating cognitive correlates of second-language literacy acquisition typically come from families that are relatively recent immigrants to the United States, often of low socioeconomic status, who are attending schools in which the primary goal of instruction is to develop English literacy (see August & Shanahan, 2006, for a review). In contrast, the participants in this study were English-speaking Canadian children who were enrolled in French immersion, which is an optional program that parents can choose for their children so that they will learn a second, socially valued language. Students are expected to acquire proficiency in French with no long-term cost to their literacy attainment in English. In our review, we treat these two learning contexts separately and then, in the Discussion section, consider whether learning context does indeed influence early predictors of second-language literacy acquisition.

Cross-Language Predictors of Reading Ability in Minority-Language Children

Researchers have investigated whether children's native language oral skills in phonological awareness, vocabulary, and grammatical ability are related to reading ability in English. They have also investigated whether rapid naming, working memory, and print knowledge assessed in children's native language predict later reading ability in English. The two languages involved in the present study, English and French, use the same alphabet, and so we focused on alphabet-sharing language pairs in our review of the literature.

Phonological Awareness

Significant cross-language correlations have been observed between Spanish phonological awareness and word reading ability in English (Branum-Martin et al., 2006; Durgunoğlu, Nagy, & Hancin-Bhatt, 1993; Gottardo, 2002; Gottardo & Mueller, 2009; Lindsey, Manis, & Bailey, 2003; Manis, Lindsey, & Bailey, 2004; Quiroga, Lemos-Britton, Mostafapour, Abbott, & Berninger, 2002; but see Swanson, Rosston, Gerber, & Solari, 2008) and between Spanish phonological awareness and English reading comprehension (Gottardo & Mueller, 2009; Lindsey et al., 2003; Manis et al., 2004; but see Swanson et al., 2008). These findings provide evidence that phonological awareness is a metalinguistic skill that transfers across alphabetic languages. Both Branum-Martin et al. (2006) and Quiroga et al. (2002) found that the correlation between Spanish phonological awareness and word reading was approximately the same for English and Spanish word identification, but Durgunoğlu et al. (1993) and Lindsey et al. (2003) observed that it was weaker for Spanish than for English. The latter finding is what is predicted by Share's (2008) hypothesis that phonological awareness is less important for reading in more transparent orthographies.

Vocabulary

There is conflicting evidence regarding whether first-language vocabulary is related to second-language reading ability. Significant correlations of Spanish vocabulary with English word identification (Lindsey et al., 2003) and English word reading fluency (Proctor, August, Carlo, & Snow, 2006) have been observed, but so have nonsignificant correlations (Gottardo, 2002; Gottardo & Mueller, 2009; Swanson, Sáez, & Gerber, 2004, 2006), and even a significant negative correlation (Swanson et al., 2008). If, as Share and Leiken (2004) have suggested, higher order language skills contribute primarily to text reading, then one might expect that first-language vocabulary would be more strongly related to second-language reading comprehension than word reading, but results are again inconsistent. Lindsey et al. (2003) found a significant correlation between Spanish vocabulary in kindergarten and Grade 1 English reading comprehension, and Carlisle, Beman, Davis, and Spharim (1999) observed that first-language vocabulary scores of Grade 1–3 students obtained in the fall were significant predictors of second-language reading comprehension in the spring. In contrast, Gottardo and Mueller (2009) found that Spanish vocabulary of Grade 1 students did not predict English reading comprehension 1 year later, nor have concurrent correlations of the two been significant in other studies (Proctor et al., 2006; Swanson et al., 2008). In the Proctor et al. (2006) study, regression analyses revealed that Spanish vocabulary in Grade 4 did account for a small but significant percentage of variance (1%) in English reading comprehension when English decoding and English vocabulary scores were included in the model. It is not yet clear, then, whether vocabulary scores in one language reflect a general ability to learn new words that facilitates reading across languages.

Grammatical Ability

There is also conflicting evidence regarding whether first-language grammatical ability is related to second-language reading

ability. A significant relationship between first-language grammatical ability and English word reading was observed in several studies (Gottardo, 2002; Lindsey et al., 2003) but not in others (Da Fontoura & Siegel, 1995; D'Angiulli, Siegel, & Serra, 2001; Gottardo & Mueller, 2009; Swanson et al., 2008). Again, one might expect that first-language grammatical ability would be more strongly related to second-language reading comprehension than word reading; however, although Lindsey et al. (2003) observed a significant correlation between their test of Spanish grammatical ability and English reading comprehension, others have not (Gottardo & Mueller, 2009; Swanson et al., 2008). As with vocabulary, then, there is not clear evidence as to whether tests of first-language grammatical ability capture a general sensitivity to grammatical structures that facilitates reading across languages.

Oral Language Proficiency

Other studies have used measures of first-language oral proficiency that do not separate vocabulary and grammatical skills, and these too have produced mixed findings. Quiroga et al. (2002) and Durgunoğlu et al. (1993) did not find a significant relationship between scores on a comprehensive test of Spanish oral language proficiency and word reading in English, and Proctor et al. (2006) did not observe a significant relationship between Spanish listening comprehension and English reading comprehension. In contrast, Proctor et al. did observe a significant relationship between Spanish listening comprehension and English word reading fluency, and Manis et al. (2004) found a significant correlation between a measure of Spanish expressive language and both word identification and reading comprehension in English. In a study of older Hispanic students, Guglielmi (2008) found that self-reported Spanish proficiency in Grade 8 was significantly associated with English reading ability in Grade 8 and also predicted growth in English reading ability from Grades 8 to 12 even after controlling for self-reported English proficiency. Spanish language proficiency was a latent variable composed of students' ratings of their speaking, listening, reading, and writing skills.

Rapid Automatized Naming (RAN)

RAN has been shown to be a good predictor of later reading in studies of English monolingual children (for reviews, see Arnell, Joanisse, Klein, Busseri, & Tannock, 2009; Moll, Fussenegger, Willburger, & Landerl, 2009), but there is not yet a consensus about what cognitive skills RAN measures. For example, Bowey (2005) suggested that it primarily reflects the degree of overlearning of letter and number names as well as the efficiency of phonological processing. Bowers and Wolf (1993) claimed that RAN reflects the ability to form orthographic representations, Moll et al. (2009) proposed that it assesses the automaticity of orthography to phonology associations at letter and letter-cluster levels, Klein (2002) suggested that it taps the efficacy of the pathways connecting the visual pattern module with the auditory language module, and Arnell et al. (2009) concluded that it assesses working memory. Some of these are general skills that should transfer across languages, and indeed RAN (objects) assessed in Spanish has been found to be significantly correlated with English word

reading and reading comprehension (Gottardo, 2002; Lindsey et al., 2003; Manis et al., 2004).

Working Memory

It might be expected that working memory is a general cognitive skill and that the benefits of a more effective working memory as assessed in one language would transfer to tasks in another language. Baddeley, Gathercole, and Papagno (1998) have argued that tasks such as digit span, and particularly pseudoword repetition, provide an indication of the capacity of the phonological loop, which plays an important role in the acquisition of new words in both native and second languages. Good phonological loop function may be particularly helpful, then, to children learning to read in a second language who must quickly acquire the vocabulary of that language in order to understand what they are reading. Indeed, Swanson et al. (2004) observed that performance on a Spanish digit span task in Grade 1 predicted English reading comprehension 1 year later, although it did not predict English word reading scores.

Other researchers have used working memory tasks that involve active manipulation of information while simultaneously storing other information. One such task, developed by Daneman and Carpenter (1980), requires the participant to read a series of sentences and later recall the last word in each sentence. Two studies that used this task with bilingual children did not observe a correlation between performance on the task in their first language and word reading scores in their second language (Da Fontoura & Siegel, 1995; D'Angiulli, et al., 2001). However, Swanson et al. (2006) used a working memory task with similar demands and did find that children's performance on the task in Spanish predicted outcomes and growth from Grades 1 to 3 in English word reading ability.

Letter, Word, and Print Knowledge

Lindsey et al. (2003) found that Spanish tests of letter-name and letter-sound knowledge, letter-word identification, and Concepts About Print were all significantly correlated with English letter-word identification and passage comprehension 1 year later. Subsequently, Manis et al. (2004) showed that a variable that included both Spanish letter-name knowledge and Concepts About Print scores in kindergarten was significantly correlated with English letter-word identification and passage comprehension in Grade 2, and they concluded that print knowledge predicts reading ability across languages.

Relative Strength of Early Predictors

The literature review has revealed that a variety of skills assessed in a child's first language are related to second-language reading. However, only Manis et al. (2004) first tested children in their native language in kindergarten, then followed them for longer than a year and examined the relative strength of the cross-language predictors in the long term. The children in their study were Spanish-speaking children in the United States from families of very low socioeconomic status. They were in an early transitional bilingual program and made a transition from Spanish to English instruction in mid-Grade 1. The Spanish predictor

variables were phonological awareness, RAN, print knowledge (Concepts About Print and letter-name knowledge), and expressive language (vocabulary and memory for sentences). Phonological awareness, RAN, print knowledge, and expressive language all accounted for unique variance in English word reading, and together accounted for 26.3% of the variance in Grade 2 word identification scores. Only print knowledge and expressive language accounted for unique variance in English passage comprehension scores in Grade 2; together they accounted for 19.8% of the variance. However, the Spanish expressive language variable accounted for very small amounts of unique variance in both English word identification (1.5%) and passage comprehension (2%).

Summary

The findings from the research with minority-language children provide evidence that component skills assessed in a child's first language can predict second-language reading ability; that is, some reading-related skills are not language specific. There is converging evidence from a number of studies that phonological awareness is a good cross-language predictor of word identification. Performance on a test of phonological awareness may reflect a general understanding that spoken language is composed of component sounds. Remaining questions concern whether phonological awareness is a good long-term cross-language predictor of reading comprehension and whether the ability of phonological awareness scores to predict reading ability across languages depends on the transparency of the second language. There are inconsistent findings regarding whether other first-language oral skills, such as vocabulary and grammatical knowledge, are cross-language predictors of reading ability. Evidence is particularly needed as to whether they are early predictors of second-language reading in the long term, especially of reading comprehension. RAN appears to be a cross-language predictor of word identification ability, indicating that whatever it is that RAN measures, it is not a skill that is specific to the language of assessment. Further evidence is needed regarding whether RAN is a long-term cross-language predictor of reading comprehension. Print knowledge was a strong cross-language predictor of both word identification and reading comprehension in the Manis et al. (2004) study. It makes sense that knowledge of print conventions (e.g., "point to the front of the book") would transfer across languages. It remains to be determined, however, whether other print knowledge, such as knowledge about letter names or letter sounds, in one language predicts later reading ability in a second language. Letter-sound knowledge in particular may be a good cross-language predictor because it reflects a child's growing understanding of the alphabetic principle.

Cross-Language Predictors of Reading Ability in Children in French Immersion

There has been a large body of research conducted on French immersion students (for reviews, see Genesee, 2004; Genesee & Jared, 2008; Swain, 1986). Most of this research has compared the performance of children in French immersion programs with children in English programs (for recent studies, see Turnbull, Hart, & Lapkin, 2003; Turnbull, Lapkin, & Hart, 2001). Genesee and Jared

(2008) pointed out that more research is needed on the early detection of students who are likely to have difficulties in French immersion so that timely remedial help can be given. Such research is important because there is considerable attrition from French immersion programs (for reviews, see Halsall, 1994; Mananavarayan, 2002). There are a variety of reasons that students leave French immersion, but two main reasons are that they are having difficulty coping with academic work in French and they are having difficulty in English reading (Halsall, 1994; Lewison & Shapson, 1989; Obadia & Thériault, 1997).

There is only one study that we are aware of that has examined kindergarten predictors of later reading ability. Trites and Price (1978, 1980) administered an impressive battery of tests to 4-year-old children in junior kindergarten. The three best predictors of their French reading ability in Grade 1 were Raven's Matrices, Wide Range Achievement Test-Reading, and teacher ratings of English auditory comprehension. These variables accounted for 43% of the variance. Additional cognitive variables that accounted for small amounts of variance were IQ, teacher ratings of English spoken language ability, and performance on an auditory discrimination test. The best predictor of Grade 1 English reading ability was Wide Range Achievement Test-Reading, which accounted for 33% of the variance. Small amounts of variance were also accounted for by performance on the auditory discrimination test, picture-naming time, and teacher ratings of English auditory comprehension. These findings provide evidence that English language skills tested before children start French immersion may be good predictors of later reading ability in both languages.

Three recent longitudinal studies of predictors of reading development in French immersion students first tested children in Grade 1 or later. These studies have provided evidence that phonological awareness skills transfer across French immersion students' two languages. Comeau, Cormier, Grandmaison, and Lacroix (1999) gave students in Grades 1, 3, and 5 both French and English versions of a phonological deletion task. The two versions were equally highly correlated with English word identification 1 year later and were also equally highly correlated with French word identification 1 year later. Furthermore, they found that Grade 1 students' combined phonological deletion task score accounted for a significant amount of variance in their word identification scores in each language a year later after age, gender, nonverbal IQ, RAN, and pseudoword repetition had been entered into regression equations. RAN, which was assessed in English, was also a good predictor of word reading ability in both languages. Similarly, MacCoubrey, Wade-Woolley, Klinger, and Kirby (2004) found that an English phonological awareness test administered to French immersion children at the start of Grade 1 could discriminate between children who, 1 year later, could successfully read words and those whose word reading was poor enough that they were considered at risk, on both English and French word identification tests. RAN, however, only discriminated between successful and at-risk students on the French word reading test. Nonverbal IQ and pseudoword repetition scores were not successful in discriminating between the two groups in either language.

Deacon, Wade-Woolley, and Kirby (2007) observed that performance on an English morphological task in Grade 1 accounted for significant unique variance in French word identification each year from Grades 1 to 3, even when Grade 1 scores on nonverbal IQ, English vocabulary, phonological awareness, and the French

version of the task were included in the regression equations. The authors suggested that the morphological task may have been a cross-language predictor of word reading because an appreciation of the way words are made up of morphemes might assist children in determining the pronunciations of words. Phonological awareness, which was tested in English, also accounted for significant unique variance in French word identification scores in Grades 1 and 2, although not in Grade 3. A limitation of all three of these more recent longitudinal studies of children in French immersion is that they examined only predictors of word identification skills, and not of reading comprehension or reading fluency.

Tingley et al. (2004) examined whether different levels of phonological awareness were associated with French immersion children's word reading ability in English and French. This study followed from Bruck et al.'s (1997) work with English- and French-speaking monolingual children, which showed that the best kindergarten predictor of French children's word reading ability in Grade 1 was syllable awareness, whereas onset-rime awareness was a significant predictor for English children. Tingley et al. presented concurrent correlations for a combined group of kindergarten and Grade 1 students. Onset-rime and phoneme awareness scores were significantly correlated with word reading ability in both languages. However, syllable awareness was significantly correlated only with French immersion children's reading of French-derived pseudowords, and not real French words. Good familiarity with the phonological structure of French may be needed for syllable awareness to be strongly associated with French reading ability. Alternatively, children who have begun formal reading instruction may show too little variability on a syllable awareness task for it to be a good longitudinal predictor. A clearer comparison between children in French immersion and the monolingual groups in Bruck et al.'s study could be made if just kindergarten children were included in the initial assessment and their word reading ability was tested in subsequent years, as was done in the current research.

The Present Study

The present study investigated kindergarten predictors of French immersion children's later reading ability in French and in English. There are few other studies of biliteracy development. One aim was to provide empirical support for measures that would be useful in the early identification of children who are particularly likely to succeed in learning to read in both French and English in a French immersion program, and also those who are likely to experience difficulties in learning to read and who would benefit from early intervention. A second aim was to address the theoretical issue of whether the skills that play a role in learning to read in a particular language are specific to that language or whether they are more general linguistic or cognitive skills. The children were first tested when they were in kindergarten, before formal reading instruction began, and they were tested yearly until the end of Grade 3. Few other studies have followed the reading development of children for as long, particularly studies of children learning to read in a second language. Because we had data on children's reading ability on the same reading tests at three points in time, we were able to use hierarchical linear modeling (HLM) to examine predictors of reading growth from Grades 1 to 3 in addition to reading outcomes. We tested children's reading extensively in both French

and English using comparable tests in the two languages. These data allowed us to examine whether predictors of second-language reading development differ from those for native language reading development and whether the nature of the orthography influences the relative strength of cross-language predictors. Much previous research has focused on word identification ability, which only partially represents the skills involved in proficient reading. Our dependent measures included not only word identification but also word reading fluency and passage reading accuracy, fluency, and comprehension. Our kindergarten test battery, which was administered in English, included nonverbal IQ, receptive vocabulary and receptive grammar, phonological awareness (syllable, onset-rime, and phoneme deletion), RAN numbers, pseudoword repetition, backward digit span, letter-name and letter-sound knowledge, and word recognition. We tested children in a large number of schools in three cities so that our results would not be specific to students in a single locale or program. Although French immersion programs exist in many schools across Canada, most prior French immersion research has been conducted in the Montréal and Ottawa areas. We chose French immersion students from three other locations that have not received as much attention by researchers.

Method

Participants

The children were from three Canadian cities (London, Hamilton, and Moncton). Two of these cities are predominantly English speaking, and one is a bilingual city where approximately one third of the population is French speaking. In each city, a school board was approached with a request to participate in the study. School board officials contacted elementary schools with French immersion programs, and nine principals agreed to participate. In each of these schools, all kindergarten children were given a letter of information about the study, and those who returned permission forms indicating parental approval were tested.

One hundred and seventy-two kindergarten children were tested at the three sites. The children came from 19 kindergarten classrooms in nine schools. Thirteen of the children did not complete any further testing. Seven of these children moved away, two did not return consent forms, and four were in English programs in Grade 1. Fifteen children were lost from the sample after Grade 1 testing. Eight of these children had moved away, one did not return the consent form, and six had transferred to English programs. Four other children were not tested in Grade 1 because they did not return consent forms, were tested in Grade 2, then did not return consent forms again in Grade 3, and so were dropped from the sample. This left 140 children in the final sample. One hundred and fifteen children were tested in all 4 years of the study. The remaining 25 children were missing data from 1 year. Eight were missing data from Grade 1 only, one was missing data from Grade 2 only, and 16 were missing data from Grade 3 only. The eight children missing Grade 1 data, the child missing Grade 2 data, and six of the children missing Grade 3 data did not return consent forms that year. Of the remaining children missing Grade 3 data, four had moved away and six had transferred to English programs.

The final sample of 140 children had a mean age of 70.7 months ($SD = 3.5$) at first testing. There were 80 girls and 60 boys. One hundred and fifteen children (82.1%) spoke only English at home,

23 children (16.4%) spoke mostly in English at home, and two children spoke other languages at home (Slovak and Vietnamese). Of the 23 children who spoke a language at home in addition to English, 11 spoke some French. Their parents were generally fairly well educated. Only 3.6% of mothers and 7.9% of fathers had not completed high school; 67.9% of mothers and 54.9% of fathers had a college diploma or university degree. The number of children from each of the testing sites was 41, 61, and 38 for Hamilton, London, and Moncton, respectively. French immersion programs begin in kindergarten in London and Hamilton and in Grade 1 in Moncton. The percentage of the day in which French was used in teaching ranged from 70% to 100% in kindergarten (in London and Hamilton) and from 50% to 90% in Grades 1–3.

Materials

Two batteries of tests were assembled for this study. In kindergarten the intent was to measure potential predictors of later reading that could be assessed in English, and in Grades 1–3 the goal was to assess progress on many components of reading in both English and French.

Kindergarten predictor measures. Participants were initially assessed in the second half of their kindergarten year. The children were tested individually in their school by a trained research assistant, during regular class time in sessions lasting approximately 20 min each.

Nonverbal intelligence. The Matrix Analogies Test (Naglieri, 1985) was used to assess nonverbal intelligence. In this test, the participant was shown a series of colored plates of design elements. From each design element a piece is missing, and the participant was required to identify which of five or six alternative pieces would best complete the design element. Reliability (alpha) is reported in the manual at .95.

Receptive vocabulary. The Peabody Picture Vocabulary Test—Third Edition (Form A; Dunn & Dunn, 1997) was used. Children had to choose from four alternative drawings the one that best matched the word spoken by the examiner. For children aged 5½–6 years, the technical manuals report that the split-half reliability for the test is .94 (all split-half reliabilities reported in this article were based on the Spearman–Brown formula).

Receptive grammar. Grammatical knowledge was assessed by the Test for Reception of Grammar (Bishop, 1982). The test consists of a series of 80 plates with four illustrations on each page. Children were required to point to the picture that best depicted a sentence spoken by the experimenter. The sentences tested knowledge of basic grammatical categories (e.g., noun, verb), embedded sentences, relative clauses, and various other syntactic elements. The items on the test are grouped into 20 blocks of four items each. All four items in a block must be answered correctly to pass a block. The child's score was the number of blocks passed out of 20. The technical manual reports split-half reliability (odd–even) at .74 for children aged 5½–6 years.

Working memory. Pseudoword repetition and backward digit span tests were used to assess working memory. Pseudoword repetition ability was assessed with a subtest of the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999). Participants heard pseudowords played on an audiocassette and were required to say each one as accurately as they could. The 18 pseudowords on the test increase in length from

one-syllable to seven-syllable items. The technical manual reports that the test–retest reliability is .68. Backward digit span was assessed with a subtest of the Wechsler Intelligence Scale for Children—Third Edition (Wechsler, 1991). The experimenter pronounced sets of digits, and the participant repeated the digits in reverse order. The sets gradually increased in length from two to eight digits. The test manual reports the reliability only for forward and backward digit span combined. For 6-year-olds the split-half reliability is .79.

Phonological awareness. A sound deletion task developed by members of the research team was used to assess phonological awareness. This task had three subtests tapping different levels of phonological representation. In the first subtest, which measured syllable awareness, a disyllabic pseudoword was pronounced by the experimenter, and the participant was asked to repeat the item (e.g., “Say *datlop*”). The participant was then asked to delete a specific syllable (e.g., “Now say what is left of *datlop* if you don’t say *dat*”). After five practice trials with feedback, the 12 test items were administered. The syllable to be deleted was word-initial in six items and word-final in six items. The second subtest tapped the level of onset-rime awareness. Monosyllabic pseudowords were pronounced by the experimenter, and the participant was asked to repeat the item and then asked to delete the onset. In six of the cases, the onset to be deleted was a consonant cluster, and in the remaining six, it was a single consonant. Five practice trials with feedback preceded the onset-awareness subtest. The third subtest assessed phonemic awareness. In six items, the target phoneme was word-final, and in the remaining six items, the target phoneme was the first consonant of a word-initial cluster. The number of correct responses out of 36 was recorded. The split-half reliability of this measure was .92 based on the responses of the 172 children tested in kindergarten.

Rapid naming. The RAN digits task from the CTOPP (Wagner et al., 1999) was used. This test consists of two forms each with a 9×4 array of digits. The time taken to read the digits in each array was measured, and the two times were summed for a total score. This score was then converted to a digits-per-second score for use in analyses. The technical manual reports that the test–retest reliability is .91.

Letter-name and letter-sound knowledge. In two sessions, participants were shown 26 cards that had a letter of the alphabet printed in uppercase letters. In one session, letter-name knowledge was assessed, and in the other, letter-sound knowledge was assessed. In cases in which a letter made more than one sound, any permissible sound was scored as correct.

Word identification. English word identification was assessed by the Word Identification subtest of the Woodcock Reading Mastery Test–Revised (Form G; Woodcock, 1998). Split-half reliability is reported in the technical manual at .98 for children in Grade 1 (no data are given for kindergarten children).

Grade 1–3 measures. In each of 3 subsequent years, the children whose parents returned consent forms signifying continued participation in the project were assessed on a variety of reading tests in both French and English. The children were tested individually in their school during regular class time in sessions lasting 20–30 min each. Only English or French tests were conducted in a session. Bilingual research assistants conducted the sessions in which French measures were administered. The testing was conducted in the latter half of each school year.

Word identification. The Word Identification subtest of the Woodcock Reading Mastery Test–Revised (Form G; Woodcock, 1998) was again used to assess English word reading accuracy, and the word identification subtest of the Batterie d’Épreuves Multidimensionnelles d’Évaluation de la Lecture (Cormier, Desrochers, & Sénéchal, 2006) was used to assess French word reading accuracy. The split-half reliability of this measure was .97 in Grade 1, .98 in Grade 2, and .96 in Grade 3.

Word reading fluency. The Test of Word Reading Efficiency (Torgesen, Wagner, & Rashotte, 1999) was administered to assess English word reading fluency. A child’s score was the number of words read correctly in 45 s. The manual reports alternate forms reliability at .97. For French, a test similar to the Test of Word Reading Efficiency was developed. The French words had similar characteristics to those of the English words, such as number of letters and syllable structure. Again, a child’s score was the total number of correctly read words in 45 s. We did not have a second form for our French version, so we could not calculate alternate-form reliability (split-half reliabilities are not appropriate for speed tests such as this; Allen & Yen, 1979). Cross-year correlations were .77 between Grades 1 and 2 and .87 between Grades 2 and 3.

Passage reading accuracy, rate, and comprehension. Passage reading ability was assessed with the Gray Oral Reading Test–Fourth Edition (GORT-4; Wiederholt & Bryant, 2001). Form B of the GORT was used for the English testing. For the French testing, Form A was translated into French by a member of the research team. The translation was then checked by another native French speaker who saw only the French version, and who translated it back into English. The GORT consists of a series of short passages followed by five comprehension questions pertaining to each passage. Participants read each passage aloud, and then the passage was removed from view and the experimenter read each question and the response alternatives aloud.¹ The time taken to read each passage was recorded as well as the number of deviations the child made from the print. The GORT provides separate scores for accuracy, rate, and comprehension. It must be kept in mind, however, that the scores for accuracy and for rate are not truly independent because children will sometimes self-correct when they make a mistake, and this affects overall reading time. The GORT manual reports that for 6- to 8-year-olds, the Cronbach’s alpha ranges from .89 to .93 for passage reading accuracy and rate and from .95 to .96 for passage comprehension. For our

¹ Keenan and Betjemann (2006) have provided evidence that the GORT contains comprehension questions that can be answered with above-chance accuracy without reading the relevant passage. We chose the test for use in our study in 2002, long before their report became available. We selected the test because it provided measures of passage reading accuracy and rate in addition to comprehension. We attempted to determine the extent to which their criticism was a problem in our study. Their participants included undergraduates and 10 children ranging in age from 7 to 15 years ($M = 11.2$), and they found that the children in the passageless condition answered fewer of the questions correctly than the undergraduates, likely because they had less background knowledge. The children in our study were 6–9 years old when they took the GORT and presumably had even less background knowledge to use in guessing. Furthermore, if children had been able to make extensive use of guessing, their comprehension scores should have been considerably higher than their accuracy and rate scores, because there is a separate stop rule for comprehension. Inspection

French version, the Cronbach's alpha was .85 for passage reading accuracy in both Grades 2 and 3 and .69 and .76 for passage reading rate in Grades 2 and 3, respectively. In Grade 1, too few passages were read before ceiling was reached to calculate reliabilities. For passage comprehension, Cronbach's alpha was .67, .90, and .89 for Grades 1, 2, and 3, respectively.

Results

The mean raw scores and standard scores (where available) on each test given in kindergarten are presented in Table 1. The table presents the means for the 140 children in the final sample and for the 32 children who left the sample, as well as the results of *t* tests comparing the two groups. Children in the final sample had above-average nonverbal IQs, slightly above-average English vocabulary scores, and average English grammar and word identification scores compared with test norms. The final sample of children had significantly higher scores on many of the measures than children who left, although the effect sizes were generally quite small. The largest difference was on knowledge of English letter names. Of the 21 children who knew fewer than 20 English letter names at the end of kindergarten, six had switched to English programs by Grade 2 and six had moved away.

Scores on English and French reading tests in Grades 1–3 for the final sample of 140 children are presented in Table 2. Inspection of the raw scores on English and French tests suggests that word identification and word fluency developed at a fairly similar pace for English and French. However, French passage reading developed much more slowly than English passage reading ability. Standard score means on English tests were at the test means by Grade 2. The finding that children had fairly good French word reading fluency by Grade 3 but weak French passage reading ability indicates that the ability to read words fluently, although necessary, is not sufficient for skilled reading.

The correlations among reading test scores in Grades 1–3 are presented in Table 3. Correlations among English test scores are shown below the diagonal, and correlations among French test scores are shown above the diagonal. Of particular interest are the cross-language correlations for each reading measure, which are shown in bold along the diagonal. In general, cross-language correlations were higher for the fluency measures than for the accuracy measures, and were higher for word-level measures than for reading comprehension. In Grade 3, for example, the cross-language correlation for word reading fluency was quite high (.70), but that for reading comprehension was low (.24). An implication

of these less-than-perfect cross-language correlations on the same reading skill is that different variables may predict performance in each language.

HLM Analysis Procedures

The analyses investigated the ability of kindergarten measures administered in English to predict Grade 3 word and passage reading ability and reading growth rates within the same language and across languages (i.e., in French). We used HLM to analyze the data from our study (Raudenbush, Bryk, & Congdon, 2006). The use of this technique is recommended for nested data sets such as ours in which reading test scores for Grades 1–3 are nested within individuals. An advantage of this analysis technique is that it can be informative not only about predictors of outcomes, in our case reading ability in Grade 3, but also about predictors of rate of growth in reading from Grade 1 to Grade 3. In some cases, variables are significant predictors of reading growth but have a negative coefficient. This means that children who score low on the predictor variable have steeper rates of growth than children with higher scores on the variable. As shown below, an example of such a variable in our data is English word identification in kindergarten. Other variables are not significant predictors of reading growth. This means that growth rates are similar for students with high and low scores on that measure in kindergarten. And finally, a few variables are significant predictors of reading growth and have a positive coefficient. This means that children who score higher on the predictor variable have steeper rates of growth than children with lower scores.

We conducted separate analyses for each of the reading measures. Each analysis had two levels. At Level 1, each student's reading development from Grades 1 to 3 on a particular reading measure was represented by an individual growth trajectory composed of a unique set of intercept and slope parameters. These individual growth parameters became the outcome variables in the Level 2 model, where we examined whether variability in these intercepts and slopes depended on student-level characteristics that we had measured in kindergarten. HLM iteratively solves for coefficients simultaneously at each of these levels.

More specifically, the Level 1 equation indicates that the reading test score (Y) for a particular student i at a given time t (in our case in a given grade) is a function of the student's true score at time 0 (or intercept: π_{0i}), plus the student's growth rate per grade (or slope: π_{1i}) multiplied by the number of grades from time 0, plus random error (e_{it}). We centered our data such that the intercept (i.e., when $t = 0$) was at Grade 3. This was done so that when we examined the influence of predictors on intercepts, we were examining their influence on Grade 3 outcomes. The Level 1 equation was, then, $Y_{it} = \pi_{0i} + \text{Grade code } \pi_{1i} + e_{it}$.

Intercepts and slopes were specified in separate Level 2 equations. In the baseline (or unconditional) model, a student's intercept (π_{0i}) is equal to the mean intercept across all individuals (β_{00}) plus random error (r_{0i}), and the student's slope (π_{1i}) is equal to the mean slope across all individuals (β_{10}) plus random error (r_{1i}). There typically was significant individual variation in these parameters, and so next we determined whether any of the measures we gave in kindergarten could predict this variability. To assess whether a particular kindergarten variable (e.g., IQ) was a significant predictor, we added a term corresponding to that variable to

of the GORT standard scores in Table 2 shows that English comprehension scores were only slightly higher than accuracy and rate scores. Finally, we had administered the Woodcock reading comprehension test in Grade 1 but dropped it in later years due to time constraints. We chose to drop the Woodcock because we wanted parallel measures of English and French reading comprehension, and we felt that a cloze test might be a problem for children with limited French productive language skills. We observed a significant correlation between Grade 1 performance on the Woodcock and English GORT comprehension scores ($r = .71, p < .001$). The GORT was, therefore, likely a reasonable assessment of our participants' reading comprehension ability. Keenan and Betjemann do make a good point, however, and we encourage future research projects to use a different measure of comprehension to see whether our findings replicate.

Table 1
Mean Raw Scores, Standard Deviations, and Standard Scores on Kindergarten Tests for the Final Sample of Children and for the Children Who Left the Sample

Kindergarten test	Final sample (<i>n</i> = 140)			Left (<i>n</i> = 32)			Comparison		
	<i>M</i>	<i>SD</i>	SS	<i>M</i>	<i>SD</i>	SS	<i>t</i> (170)	<i>p</i>	η^2
Nonverbal IQ	16.6	7.7	116.8	13.4	6.5	112.7	2.19	<.03	.03
Grammar	13.2	3.3	104.4	10.9	3.5	94.8	3.48	<.001	.07
Vocabulary	89.9	13.6	108.8	84.8	14.6	105.1	1.87	<.07	.02
Digit span	2.8	1.3		2.1	1.6		2.77	<.01	.04
Pseudoword repetition	6.1	3.4	8.3	6.4	3.0	8.5	<1.00	<i>ns</i>	
Phonological awareness	17.7	7.9		14.4	7.0		2.14	<.05	.03
RAN digits	1.1	0.3		0.9	0.3		2.54	<.02	.04
Letter names	24.6	3.2		20.7	6.1		5.20	<.001	.14
Letter sounds	19.0	6.2		15.3	7.5		2.95	<.005	.05
Word identification	8.8	13.2	103.6	4.7	8.5	94.2	1.70	<i>ns</i>	

Note. SS = standard score; RAN = rapid automatized naming.

the intercept and slope equations. Predictors were grand mean centered. For example, the Level 2 model including IQ as a predictor consisted of the equations $\pi_{0i} = \beta_{00} + \beta_{01}(\text{IQ}) + r_{0i}$ for intercept and $\pi_{1i} = \beta_{10} + \beta_{11}(\text{IQ}) + r_{1i}$ for slope. The HLM program estimates values for the coefficients β_{01} and β_{11} such that for each one, error variance across students is minimized. These coefficients represent the impact of IQ on the intercept and the slope, respectively. To examine whether the coefficients differ significantly from 0, a *t* is calculated by dividing the coefficient by its standard error. A significant *t* indicates that including the predictor variable significantly improves the fit of the model to the data.

The first step in our analysis procedure was to examine the influence of single predictors on Level 2 equations for intercept and slope. These analyses allowed us to see how well each variable predicted Grade 3 reading test scores and reading growth rates on its own. The results of the HLM analyses for each of the five reading measures are reported in Table 4. To simplify the presentation of the data, we have reported only the results of the *t* tests for these analyses. Another series of analyses sought to determine the best model for each dependent measure using a combination of the strongest predictors from the single-predictor analyses. There is both a practical and a theoretical rationale for conducting these analyses. It is time-consuming and expensive to administer all of

Table 2
Test Means, Standard Deviations, and Standard Scores on English and French Reading Tests in Grades 1–3 for the Participants in the Final Sample

Test	English			French	
	<i>M</i>	<i>SD</i>	SS	<i>M</i>	<i>SD</i>
Grade 1					
Word identification	32.2	18.6	113.5	15.5	15.2
Word fluency	27.8	17.6	100.2	21.5	12.3
Passage rate	6.5	8.6	7.8	3.8	3.8
Passage accuracy	7.3	8.5	7.8	1.9	3.1
Passage comprehension	10.2	9.1	9.1	2.2	2.4
Grade 2					
Word identification	53.6	16.6	110.2	45.9	24.9
Word fluency	49.3	16.0	104.6	41.3	13.6
Passage rate	16.8	10.5	9.7	9.6	4.6
Passage accuracy	16.9	10.4	9.8	7.5	5.2
Passage comprehension	18.8	10.2	10.4	6.5	6.1
Grade 3					
Word identification	64.4	12.3	110.1	55.9	18.8
Word fluency	61.5	12.4	108.2	50.8	12.1
Passage rate	24.8	9.5	11.2	12.9	4.5
Passage accuracy	23.9	9.6	10.6	9.7	5.1
Passage comprehension	27.4	8.4	12.1	11.4	8.4

Note. Passage standard scores (SS): *M* = 10, *SD* = 3. Standard scores are not available for French tests.

Table 3
Correlations Among Reading Tests in Grades 1–3

Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Grade 1															
1. Word identification	.65	.79	.64	.52	.33	.59	.70	.52	.57	.37	.51	.58	.43	.44	.33
2. Word fluency	.95	.77	.78	.65	.37	.59	.77	.67	.43	.33	.51	.65	.51	.47	.36
3. Passage rate	.84	.90	.79	.50	.35	.57	.72	.68	.49	.43	.53	.62	.59	.47	.43
4. Passage accuracy	.87	.91	.93	.45	.56	.49	.66	.48	.67	.47	.46	.59	.44	.65	.37
5. Passage comprehension	.67	.68	.67	.70	.20	.41	.42	.34	.29	.36	.28	.32	.35	.40	.40
Grade 2															
6. Word identification	.81	.79	.66	.70	.61	.66	.76	.66	.78	.43	.80	.72	.59	.71	.45
7. Word fluency	.82	.83	.67	.69	.57	.90	.74	.85	.72	.54	.71	.87	.75	.68	.51
8. Passage rate	.87	.90	.83	.82	.66	.85	.90	.64	.70	.54	.61	.75	.79	.63	.54
9. Passage accuracy	.82	.83	.74	.78	.62	.87	.85	.90	.54	.47	.67	.70	.60	.84	.51
10. Passage comprehension	.55	.52	.48	.49	.60	.54	.54	.59	.59	.42	.40	.43	.47	.51	.45
Grade 3															
11. Word identification	.72	.71	.62	.65	.52	.86	.81	.76	.80	.44	.65	.74	.59	.71	.45
12. Word fluency	.73	.74	.61	.62	.46	.81	.86	.81	.76	.46	.81	.70	.76	.70	.55
13. Passage rate	.80	.82	.77	.74	.60	.83	.88	.91	.84	.54	.82	.88	.65	.68	.55
14. Passage accuracy	.66	.66	.59	.65	.49	.78	.77	.74	.78	.42	.81	.71	.82	.49	.58
15. Passage comprehension	.46	.47	.43	.45	.54	.53	.53	.57	.49	.51	.52	.48	.60	.56	.24

Note. Correlations among reading variables in English are below the diagonal, correlations among reading variables in French are above the diagonal, and cross-language correlations are in bold along the diagonal. Correlations greater than .18 are $p < .05$; greater than .23, $p < .01$; and greater than .28, $p < .001$.

the 10 predictor measures to kindergarten children. Modeling with HLM reveals the subset of predictor measures that constitute the most efficient test battery. The best models can inform theory because the predictor measures that are found to enter into these models give an indication of the critical skills that are involved in learning to read in a first and second language. The best multiple-predictor model for each dependent measure is presented in Table 5. No other predictors had significant coefficients when added to any of these models.

Predictors of English and French Reading Development

Word identification. Each of the kindergarten tests was a significant predictor of Grade 3 English word identification. These findings were expected because we carefully chose our predictors based on a thorough review of the literature on English reading development, and much of that research used word identification as the dependent measure. Furthermore, each of the English kindergarten tests had a negative coefficient for slope, and in all cases but one (backward digit span) the coefficient was significant. The negative coefficient indicates that children with lower scores on the kindergarten tests had faster English word identification growth rates than children with higher scores on the kindergarten tests. Further modeling with HLM revealed that just a subset of these predictors makes the best possible prediction about future English word identification skills that can be made from these measures. The best multiple-predictor model included phonological awareness, English word identification in kindergarten, and nonverbal IQ as predictors of intercepts and English kindergarten word identification as a predictor of growth rates. This model accounted for 37.4% of variance in Grade 3 English word identification

scores and 68.5% of variance in growth rates. A model with RAN in place of nonverbal IQ was almost as good, accounting for 35.9% of variance in Grade 3 English word identification scores and 67.6% of variance in growth rates.

A goal of this research was to investigate whether our English kindergarten measures tapped general linguistic or cognitive skills that would predict reading ability in French. As can be seen in Table 4, many of our English kindergarten measures were significant cross-language predictors of word identification ability. All but the two weakest predictors of English word identification ability in Grade 3 (pseudoword repetition and English vocabulary) were also significant predictors of French word recognition ability in Grade 3. In most cases, the English predictors accounted for less variance in Grade 3 French word identification scores than in Grade 3 English word identification scores, but knowledge of English letter names and letter sounds actually accounted for more variance in French word identification. No predictors of slope were included because the analysis of the unconditional model indicated that there was not significant variation in rates of growth in French word recognition ability across students in our sample. Again, modeling with HLM revealed that just a subset of these predictors makes the best possible prediction about future French word identification skills that can be made from these measures. The best multiple-predictor model included phonological awareness, English letter-sound knowledge, and RAN. When these three predictors were entered into equations simultaneously, all still had significant intercept coefficients. Together they accounted for 25.0% of variance in Grade 3 French word identification scores.

Word reading fluency. Only seven of the English kindergarten predictors were significant predictors of English word reading fluency in Grade 3. RAN was by far the best predictor,

Table 4
Effects of Kindergarten Predictors on Intercept and Slope Parameters for Reading Tests in English and French (*t* Values When Each Predictor is Entered Alone)

Predictor	Word identification		Word fluency		Passage fluency		Passage accuracy		Passage comprehension	
	English	French	English	French	English	French	English	French	English	French
Intercepts (Grade 3 outcomes)										
Nonverbal IQ	3.89***	3.54***	3.43***	2.82**	4.53***	3.16**	4.97***	2.34*	4.66***	3.84***
Grammar	4.00***	4.65***	3.37***	4.11***	5.18***	4.56***	3.95***	3.13**	6.40***	5.56***
Vocabulary	2.03*	1.87	1.63	0.94	2.83**	1.92	2.69**	0.49	3.98***	2.00*
Digit span	2.95**	2.50*	3.11**	1.90	3.59***	2.27*	3.59***	1.46	4.01**	3.36**
Pseudoword repetition	1.97*	1.77	1.61	1.51	2.42*	1.66	1.75	0.89	1.99*	0.00
Phonological awareness	5.18***	5.48***	4.43***	3.90***	5.82***	3.22**	5.61***	3.01**	7.36***	2.75**
RAN	5.84***	6.17***	6.57***	6.98***	7.31***	5.87***	6.41***	4.77***	5.20***	3.44***
Letter names	3.11**	4.29***	3.21*	3.88***	4.52***	3.25**	4.28***	3.70***	4.34**	2.21*
Letter sounds	2.45*	6.80***	1.84	3.88***	3.13**	3.93***	3.10**	5.73***	5.86***	5.00***
Word identification	6.51***	6.25***	5.07***	3.70**	7.41***	3.64***	5.11***	4.01***	8.78***	3.45***
Slopes (growth rates)										
Nonverbal IQ	-2.00*	—	-2.56*	-0.60	0.86	0.05	1.34	1.70	—	3.04**
Grammar	-2.45*	—	-3.09**	-1.25	0.70	-0.11	-0.17	1.44	—	3.44***
Vocabulary	-2.01*	—	-2.27*	-1.18	1.70	-0.14	1.04	-0.13	—	1.16
Digit span	-1.43	—	-1.05	0.45	1.64	0.82	1.97*	1.88	—	2.74**
Pseudoword repetition	-2.64**	—	-3.72***	-1.34	-0.51	0.23	-0.91	0.59	—	-0.20
Phonological awareness	-4.58***	—	-4.75***	-1.88	0.42	-0.72	0.33	1.84	—	1.70
RAN	-4.38***	—	-4.94***	-0.68	-0.93	0.19	-0.07	3.31**	—	2.61**
Letter names	-4.90***	—	-2.83**	-1.72	1.75	-0.24	1.21	1.98*	—	1.25
Letter sounds	-4.69***	—	-4.33***	-1.66	-0.82	0.35	-1.09	4.03***	—	3.20**
Word identification	-5.03***	—	-8.15***	-3.16***	-3.97***	-0.62	-3.05**	2.12*	—	2.17*

Note. Dashes indicate where predictors of slope were not calculated because there was insufficient variation in rates of growth. RAN = rapid automatized naming.

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

accounting for 24.8% of variance in word fluency scores. Again, each of the English kindergarten tests had a negative coefficient for slope, and in all cases but one (backward digit span) the coefficient was significant. Phonological awareness was a significant predictor of intercepts when added with RAN, and kindergarten word identification was a very strong predictor of growth rates. The model with these three variables accounted for 25.2% of variance in Grade 3 English word reading fluency scores and 94.7% of variance in growth rates.

RAN was clearly not a language-specific predictor of word reading fluency in our study. It accounted for an impressive 29.9% of variance in Grade 3 French word reading fluency. Six other kindergarten variables were also significant cross-language predictors of Grade 3 French word reading fluency including nonverbal IQ, grammatical knowledge, phonological awareness, letter names, letter sounds, and word identification. However, only letter sounds improved the prediction of Grade 3 French word reading fluency when added to Level 2 equations that included RAN. English word identification in kindergarten was the best predictor of growth rates, and it had a negative coefficient for slope. The model with these three variables accounted for 31.1% of variance in Grade 3 French word reading fluency scores and 30.5% of variance in growth rates.

Passage reading rate. Each of the 10 kindergarten tests was a significant predictor of Grade 3 English passage reading rate, and seven accounted for 10% or more of the variance in Grade 3

outcome scores. Only English word identification in kindergarten was a significant predictor of growth rates, and it had a negative coefficient for slope. The best multiple-predictor model included RAN and English kindergarten word identification as predictors of intercepts and the latter variable as a predictor of slopes. Together they accounted for 33.7% of variance in Grade 3 English passage reading rate scores and 5.9% of variance in growth rates.

All but two of the kindergarten predictor variables (vocabulary and pseudoword repetition) were significant cross-language predictors of Grade 3 French passage reading rate. RAN was again a strong cross-language predictor of Grade 3 reading rate, accounting for an impressive 28.2% of variance in scores. When English word identification and letter sounds were added, that figure rose to 33.9%. An equivalent amount of variance in French passage reading rates was accounted for by a model in which English grammar was included instead of letter sounds. None of the kindergarten measures were significant predictors of growth rates.

Passage reading accuracy. All English kindergarten predictors except pseudoword repetition were significant predictors of Grade 3 English passage reading accuracy, and once again seven predictors accounted for 10% or more of the variance in Grade 3 scores. English word identification had a significant (and negative) coefficient for slope, and backward digit span had a significant positive slope coefficient. None of the other slope coefficients were significant. The significant positive slope for digit span means that children with a higher digit span had a faster rate of

Table 5
Best Models With Kindergarten Predictors

Dependent measure and predictor	Parameter	Fixed effects			Random effects		
		Coefficient	SE	<i>t</i>	Variance	% variance	χ^2
English reading tests							
Word identification							
Phonological awareness	Intercept	0.62	0.14	4.32***			
Nonverbal IQ	Intercept	0.27	0.13	2.07*			
Word identification	Intercept	0.19	0.07	2.67**			
Slope		-0.23	0.05	-5.01***			
Model	Intercept				75.82	37.4	329.92***
	Slope				4.28	68.5	158.90
Word fluency							
Phonological awareness	Intercept	0.42	0.12	3.43***			
RAN	Intercept	15.86	3.26	4.87***			
Word identification	Slope	-0.26	0.03	-8.05***			
Model	Intercept				93.32	25.2	425.23***
	Slope				0.51	94.7	134.30
Passage rate							
RAN	Intercept	8.26	1.95	4.24***			
Word identification	Intercept	0.28	0.05	5.89***			
Slope		-0.06	0.01	-4.02***			
Model	Intercept				60.01	33.7	813.83***
	Slope				2.53	5.9	178.53**
Passage accuracy							
Nonverbal IQ	Intercept	0.15	0.07	2.10*			
Phonological awareness	Intercept	0.21	0.08	2.50*			
RAN	Intercept	5.88	2.03	2.90**			
Word identification	Intercept	0.16	0.05	2.91**			
Slope		-0.06	0.02	-3.13**			
Model	Intercept				52.77	37.0	512.49***
	Slope				3.08	20.4	173.35*
Passage comprehension							
Nonverbal IQ	Intercept	0.19	0.08	2.33*			
Grammar	Intercept	0.94	0.17	5.36***			
phonological awareness	Intercept	0.29	0.07	3.89***			
Model	Intercept				17.40	58.9	195.17***
	Slope				0.38		127.86
French reading tests							
Word identification							
Phonological awareness	Intercept	0.48	0.20	2.41*			
RAN	Intercept	16.49	4.60	3.58***			
Letter sounds	Intercept	0.51	0.20	2.61**			
Model	Intercept				254.86	25.0	339.78***
	Slope				12.96		133.64
Word fluency							
RAN	Intercept	14.27	2.58	5.52***			
Letter sounds	Intercept	0.48	0.14	3.44***			
Word identification	Slope	-0.15	0.03	-4.70***			
Model	Intercept				94.40	31.1	468.48***
	Slope				3.64	30.5	167.71*
Passage rate							
RAN	Intercept	4.57	0.95	4.80***			
Letter sounds	Intercept	0.07	0.03	2.13*			
Word identification	Intercept	0.09	0.02	4.37***			
Model	Intercept				11.63	33.9	451.83***
	Slope				0.90		175.16*
Passage accuracy							
RAN	Intercept	2.64	1.02	2.59*			
Letter sounds	Intercept	0.35	0.07	5.12***			
Slope		0.10	0.03	4.12***			
Model	Intercept				19.09	26.7	575.36***
	Slope				1.20	25.0	165.67*

(table continues)

Table 5 (continued)

Dependent measure and predictor	Parameter	Fixed effects			Random effects		
		Coefficient	SE	<i>t</i>	Variance	% variance	χ^2
Passage comprehension	Intercept	0.81	0.16	4.90***			
	Slope	0.34	0.09	3.66**			
Letter sounds	Intercept	0.08	0.03	2.66**			
	Slope	0.07	0.02	3.10**			
Word identification	Intercept				39.57	25.1	548.84***
	Slope				9.21	11.3	266.77***

Note. RAN = rapid automatized naming.
 * $p < .05$. ** $p < .01$. *** $p < .001$.

growth in English passage reading accuracy than those with a lower digit span. The best multiple-predictor model included RAN, phonological awareness, English word identification, and nonverbal IQ as predictors of intercepts and English word identification as a predictor of growth rates (see Table 5). The model including those four predictors accounted for 37.0% of variance in Grade 3 passage reading accuracy and 20.4% of variance in growth rates. Although digit span was a significant predictor of slope, no model in which digit span was included accounted for more variance in growth rates than the model in Table 5.

Seven of the English kindergarten predictors were also significant cross-language predictors of Grade 3 French passage reading accuracy (all except pseudoword repetition, vocabulary, and digit span). It is interesting that four of these (RAN, letter names, letter sounds, and English word identification) had significant positive slope coefficients, indicating that growth rates were faster for children who had higher kindergarten scores on these measures. Knowledge of letter sounds was a particularly strong cross-language predictor of both intercepts and slopes, accounting for 22.2% of variance in Grade 3 French passage reading accuracy scores and 21.8% of variance in growth rates. RAN was also a strong cross-language predictor. When it was added to the model with letter sounds, these figures increased to 26.7% and 25.0%, respectively. No other predictors had significant coefficients when added to this model.

Passage comprehension. Each of the 10 kindergarten tests was a significant predictor of Grade 3 English passage comprehension, and seven accounted for 10% or more of the variance in Grade 3 scores. No predictors of slope were included because there was not significant variation in rates of growth. English grammatical ability accounted for an astounding 53.2% of variance in Grade 3 English reading comprehension scores. Adding nonverbal IQ to the model resulted in the greatest increase in variance accounted for (to 57.5%) of the remaining variables. Surprisingly, adding vocabulary to the model with grammar did not improve the prediction of intercepts, despite vocabulary being a fairly strong predictor on its own. However, vocabulary and grammar had a fairly high intercorrelation among kindergarten predictor measures ($r = .57$). When phonological awareness was added as the third predictor with grammar and nonverbal IQ, its intercept coefficient was significant, but the increase in variance accounted for was only 1.4%.

All but one of the English kindergarten predictor variables (pseudoword repetition) were significant cross-language predictors

of Grade 3 French passage comprehension. Slope coefficients for these nine predictors were all positive, and six were significant. It is interesting that English grammatical ability in kindergarten accounted for 19.4% of variance in French reading comprehension scores in Grade 3 and 11.3% of variance in growth rates. Adding letter sounds and English word identification in kindergarten to English grammatical ability as predictors of the intercepts produced a model that accounted for 25.1% of the variance in Grade 3 French reading comprehension scores. No other variable, when added to English grammatical ability, improved the prediction of the slopes.

Levels of phonological awareness. When phonological awareness was included in the preceding analyses, we used the total score on the test. However, we had deliberately included an equal number of items that assessed syllable, onset-rime, and phoneme awareness when we created the test, so that we could investigate the subsidiary issue of whether English and French word identification are predicted by different levels of phonological awareness. An advantage of our study is that we can examine this question within a single group of children instead of between children with different backgrounds (Bruck et al., 1997). Specifically, we investigated the hypothesis that French word identification is better predicted by syllable-level awareness than onset-rime awareness, and vice versa for English word identification. Our data can also provide evidence relevant to the controversy in the monolingual English literature about whether onset-rime awareness or phoneme awareness better predicts later word identification ability (Goswami & Bryant, 1990; Hulme et al., 2002).

Children had the highest scores on the syllable deletion items ($M = 10.0$, $SD = 2.6$), lower scores on the onset-rime deletion items ($M = 5.4$, $SD = 5.0$), and the lowest scores on the phoneme deletion items ($M = 2.3$, $SD = 2.6$). The maximum score was 12 in each case. Table 6 shows the results of a series of HLM analyses. There was not significant variance in the slopes for French word identification, and so predictors were entered only for intercepts in French models. Initially, each level of phonological awareness was added as a single predictor. Table 6 shows that each of the phonological awareness levels was a significant predictor of Grade 3 word identification, both for English and for French. Onset-rime awareness accounted for the most variance in outcomes. In addition, each was a significant predictor of growth rates in English. Slope coefficients were negative. We next added English word identification in kindergarten to each of the models. Column 6 shows the new intercept and slope t values for syllable,

Table 6
Hierarchical Linear Modeling Analyses Showing the Contribution of Three Levels of Phonological Awareness to Word Identification in English and French

Level of phonological awareness	Parameter	Alone				Plus word ID <i>t</i>	All 4 <i>t</i>
		Coefficient	<i>SE</i>	<i>t</i>	% variance		
English word identification							
Syllables	Intercept	1.32	0.54	2.42*	8.9	2.01*	0.94
	Slope	-0.63	0.23	-2.76**	13.8	-2.06*	-1.54
Onset-rimes	Intercept	1.13	0.20	5.63***	25.2	3.98***	2.95**
	Slope	-0.44	0.11	-4.15***	32.0	-1.67	-0.84
Phonemes	Intercept	1.50	0.41	3.64***	11.8	2.01*	1.16
	Slope	-0.58	0.21	-2.72**	13.6	-0.31	0.26
French word identification							
Syllables	Intercept	1.79	0.52	3.42***	9.8	2.81**	1.88†
Onset-rimes	Intercept	1.36	0.26	5.22***	14.9	3.03**	1.91†
Phonemes	Intercept	1.78	0.56	3.16**	3.9	0.98	0.19

Note. Plus word ID = kindergarten word identification in English is also in the model; All 4 = the three phonological awareness levels and English kindergarten word identification are in the model.

† $p < .065$. * $p < .05$. ** $p < .01$. *** $p < .001$.

onset-rime, and phoneme awareness when word identification was a second variable in the models. All intercept predictors were still significant except phoneme awareness for French word identification. Finally, all three levels of phonological awareness and English word identification in kindergarten were entered together into a single model for each language. The last column in Table 6 shows the new intercept and slope *t* values for each of the levels of phonological awareness in this model. For English word identification, onset-rime awareness was the only significant intercept predictor. For French word identification, both syllable and onset-rime awareness approached significance.

Discussion

This study was a longitudinal investigation of children who were in the process of learning to read in two languages simultaneously. A goal of the study was to investigate the cognitive factors underlying individual differences in reading proficiency in each language. We wanted to provide empirical support for measures that can identify children who are particularly likely to be successful readers in an enrichment second-language program as well those in the program who are at risk for reading difficulties so that they may receive timely intervention. Of particular theoretical interest was to understand whether the skills that play a role in learning to read are specific to the language or whether they are more general linguistic or cognitive skills, and whether the nature of the orthography influences the relative strength of cross-language predictors. We discuss the theoretical issues first and then the practical issue.

Language Specificity of Predictors

The strong correlations between word reading scores in English and French provide an indication that similar processes are involved in reading words in each language. This finding is consistent with Cummins's (1978, 1980, 1984) linguistic interdependence view that first-language competence is related to second-

language abilities. However, the relatively weak correlation between passage comprehension scores in English and French suggest that Cummins's hypothesis might not be entirely correct. Verhoeven (1994) suggested that not all first-language skills might transfer to the second language, and our results suggest that this is the case.

Phonological awareness. Our study provided evidence that phonological awareness is not a language-specific skill. Phonological awareness, which was assessed with English-like pseudowords, was a significant predictor of French reading ability in Grade 3 for all five reading measures when it was alone in models and a significant unique predictor in the best model of French word identification, suggesting that the benefits of being able to segment the sound stream in English transfer to learning to read in French. Phonological awareness scores were, however, generally a weaker predictor of French than of English reading scores. Because French has more consistent spelling-sound correspondences than English, this finding provides evidence for Share's (2008) hypothesis that phonological awareness is more strongly related to reading in less transparent orthographies. Our study provides a particularly strong test of Share's view because our comparisons are made within participants, so that sociocultural explanations of differences are less likely than for between-participant comparisons. Our results add to the growing body of work suggesting that phonological awareness predicts reading ability across alphabetic languages (Comeau et al., 1999; Deacon et al., 2007; Durgunoğlu et al., 1993; Gottardo, 2002; Gottardo & Mueller, 2009; Lindsey et al., 2003; MacCoubrey et al., 2004; Manis et al., 2004; Quiroga et al., 2002).

Our observations concerning the specific level of phonological awareness that best predicts later French word identification differ from Bruck et al.'s (1997). They found that syllable-level awareness was the best predictor of French word identification for French-speaking children, whereas we observed that onset-rime and syllable awareness were equally good predictors for our English-speaking children learning to read in French, particularly

when kindergarten word identification was included in models. The difference in findings for French word identification may have occurred because the children in our study used knowledge of the sound structure of both English and French when reading French words, whereas the children in Bruck et al.'s study only had knowledge of French phonology. Our observation that syllable-level phonological awareness was a significant predictor of French word reading ability for children in French immersion, in contrast to Tingley et al.'s (2004) results, may be because our sample included only kindergarten children. Syllable-level awareness may not be a good predictor of reading ability in older children who have already been exposed to formal reading instruction. And finally, our finding that onset-rime awareness was a better predictor of English word reading ability than phoneme awareness informs a debate in the English monolingual literature, supporting the position of Goswami and Bryant (1990) instead of that of Hulme et al. (2002).

Vocabulary. In contrast to phonological awareness, English vocabulary was largely a language-specific predictor in our study. This is particularly evident when comparing the strength of English vocabulary as a predictor of English and French passage comprehension when vocabulary was alone in the model. It was a robust predictor of English passage comprehension, accounting for 26.6% of variance, but a barely significant predictor of French passage comprehension, accounting for only 3% of variance. Vocabulary was a significant predictor of performance on all other Grade 3 English reading tests except word reading fluency when it was alone in models, but not on any other French reading test. These results suggest that a measure of receptive vocabulary does not capture a general ability to acquire vocabulary that transfers to reading in a new language. Other studies of shorter duration have also found that vocabulary is not a cross-language predictor of word reading ability (Gottardo, 2002; Gottardo & Mueller, 2009; Swanson et al., 2004, 2006) and is at best a weak cross-language predictor of reading comprehension (Lindsey et al., 2003; Proctor et al., 2006; Trites & Price, 1980).

Grammatical ability. In contrast to vocabulary, English grammatical ability was a remarkably good cross-language predictor. It was a significant predictor of French reading ability in Grade 3 for all five reading measures when it was alone in models, and it was a unique predictor in the best model for French reading comprehension and in one of the two equivalent best models for French passage reading rate. It was also a significant predictor of growth in the best model for French reading comprehension, meaning that children who had higher scores on the test of English grammar in kindergarten developed French reading comprehension skills more quickly. Our findings suggest that the ability to understand grammatical structures is not specific to a particular language but transfers across languages, such that children who are better able to comprehend grammatical structures in their native language more readily learn to understand a second language. Our results therefore partially support Cummins's (1978, 1980, 1984) developmental interdependence hypothesis. Our findings suggest a more specific claim, that is, that the developmental level of native language grammatical skills, rather than vocabulary knowledge, has an impact on second-language development.

Our finding is the strongest evidence to date that first-language grammatical skills in kindergarten predict later second-language reading comprehension ability. Trites and Price's (1980) French

immersion study did show that one of the three best predictors of Grade 1 performance on the Test de Rendement en Français was the teacher's rating of children's English auditory comprehension. However, their finding is only weak support for a relation between first-language grammatical skills and second-language reading comprehension. Their teacher ratings of English auditory comprehension may have been influenced by a variety of language skills, not just grammatical competence, and the test used as the dependent measure assessed French vocabulary and spelling in addition to French reading. Lindsey et al. (2003) showed that the ability to repeat Spanish sentences of increasing length and grammatical complexity in kindergarten predicted unique variance in Grade 1 English passage comprehension scores. However, working memory skills may have been partly responsible for that relationship. Two studies that failed to find a relationship between first-language grammatical ability and second-language reading comprehension (Gottardo & Mueller, 2009; Swanson et al., 2008) used a brief oral cloze test (14 and 20 items, respectively). These tests may not have been as sensitive to individual differences in grammatical ability as the lengthier Test for the Reception of Grammar (Bishop, 1982) used here. Our finding regarding the cross-language relationship between grammatical ability and word identification is consistent with Deacon et al.'s (2007) results, also from children in French immersion. We further demonstrated, though, that when RAN and letter-sound knowledge (two variables that were not included in their study) are entered into the model for French word identification, grammatical ability no longer makes a significant contribution.

Rapid naming. Another particularly robust cross-language predictor in our study was RAN. It was a significant predictor of French reading ability in Grade 3 for all five reading measures when it was alone in models and a unique predictor in all best models except French reading comprehension. The finding for word identification is consistent with that of several previous studies that have shown a cross-language relationship between RAN and second-language word identification (Comeau et al., 1999; Gottardo, 2002; Lindsey et al., 2003; MacCoubrey et al., 2004; Manis et al., 2004). Our observation that RAN was a good cross-language predictor of reading ability, and especially fluency, suggests that RAN measures a process or processes that are not language specific and that are particularly related to speed of processing. Candidate processes that have been put forward are the ability to form orthographic representations (Bowers & Wolf, 1993), the efficacy of the pathways connecting the visual pattern recognition module with the auditory language module (Klein, 2002), and working memory processes (Arnell et al., 2009). All of these proposals are consistent with the finding that RAN is a general, and not language-specific, predictor of reading ability.

Other research has suggested that RAN is a better predictor of word reading ability in more transparent languages than in less transparent languages such as English (van den Bos, 1998; Wimmer, 1993; Wolf, Pfeil, Lotz, & Biddle, 1994), but here we have demonstrated that within the same children, RAN's ability to predict Grade 3 English and French word identification scores is comparable (correlations between RAN and Grade 3 word identification were .37 and .30 for English and French, respectively). RAN was a stronger predictor of word reading fluency than word identification in both languages, but again RAN's ability to predict Grade 3 English and French word reading fluency scores is com-

parable (correlations between RAN and Grade 3 word reading fluency were .43 and .46 for English and French, respectively). However, RAN would appear to be a better predictor of word reading ability in more transparent languages if word reading ability is assessed with a fluency test in studies of transparent languages (e.g., de Jong & van der Leij, 2002) but an identification test in English (e.g., the frequently used Woodcock test). One could speculate, though, that RAN might be a better predictor of word reading fluency in French than in English for children tested beyond Grade 3. This is because RAN's slope coefficient was significant and negative for English word reading fluency, whereas the slope coefficient for French reading fluency was not significant.

Letter-name and letter-sound knowledge. English letter-name and letter-sound knowledge in kindergarten were significant predictors of French reading ability in Grade 3 for all five reading measures when each was alone in models. Letter-sound knowledge was a particularly good predictor of French reading ability, appearing as a predictor of Grade 3 scores in all five best models. It is interesting that English letter-sound knowledge was also a significant predictor of growth in French passage reading accuracy and comprehension with positive coefficients, which means that children who knew more English letter sounds in kindergarten had faster growth rates on those two French tests than children who knew fewer English letter sounds in kindergarten. Although many letter sounds differ between English and French, children appear to be able to transfer across languages the more general understanding that letters correspond to sounds in spoken words. Such an understanding would contribute to the development of efficient decoding skills in alphabetic languages. The finding that English letter-sound knowledge was generally a better cross-language predictor of reading ability than phonological awareness suggests that French reading ability is most facilitated by a good grasp of the alphabetic principle in English rather than simply an awareness that spoken language consists of component sounds.

Word identification. Kindergarten English word identification ability was a significant cross-language predictor of Grade 3 outcomes for each French reading measure when it was alone in models. This finding, along with the observation that all correlations between English kindergarten word identification and subsequent French reading tests were positive, suggests that learning to read in English prior to beginning a French immersion program does not typically lead to confusion when children encounter subsequent reading instruction in French. Prior ability to read in English may indeed facilitate later learning to read in French, although it is possible that the characteristics of children that cause them to become precocious readers in their native language also contribute to their being able to easily learn to read in a second language.

Memory. We included two memory tasks: pseudoword repetition and backward digit span. Pseudoword repetition is believed to assess phonological loop capacity (Baddeley et al., 1998). Pseudoword repetition (with English-derived pseudowords) was a significant, albeit weak, predictor of Grade 3 English reading on three measures when it appeared alone in models, but was not a significant predictor of Grade 3 performance on any of the French reading tests. Pseudoword repetition was also not a predictor of French word identification in two other studies of children in French immersion that were of shorter duration (Comeau et al.,

1999; MacCoubrey et al., 2004). It appears, then, to be a language-specific predictor, perhaps because pseudoword repetition scores are influenced by knowledge of the language from which they were derived (Gathercole, 1995; Thorn & Gathercole, 1999).

The backward digit span task requires both storage of the sequence of digits spoken by the examiner and active manipulation of that information to produce the sequence in reverse. In contrast to the findings for pseudoword repetition, backward digit span in English was a significant predictor of Grade 3 French reading ability for three measures and approached significance on a fourth. It was a particularly good predictor of French reading comprehension, of both intercept and growth parameters, although it did not account for significant additional variance when added to the best model for reading comprehension. Thus, backward digit span appears to be a predictor that is not language specific. Cross-language transfer may have been greatest on the reading comprehension measure because that test had the greatest memory demands. Children had to answer the comprehension questions after each story without looking back at the story.

A possible reason that backward digit span performance in English predicted French reading ability is that the task involved the manipulation of numbers rather than verbal material. However, the numbers were spoken aloud to participants in English, and they likely manipulated number names in memory. One could test whether it is the numerical nature of the stimuli that is responsible for its strength as a cross-language predictor by comparing the predictive ability of scores on a backward digit span task with that of scores on a similar task involving words (*bun, shoe, tree, door*, etc.). In hindsight, although quick to administer, the backward digit span task may not have been the most sensitive measure of the active manipulation and storage of information in working memory that we could have chosen. Swanson et al. (2006) found that a more demanding working memory measure that they administered in Spanish predicted outcomes and growth from Grades 1 to 3 in English word reading ability. On the basis of our findings, one could speculate that such a measure might be a particularly good cross-language predictor of reading comprehension and may even survive in a model with other strong cross-language predictors of reading comprehension.

Summary. Our findings provide evidence that at least some of the skills that play a role in learning to read are general cognitive and linguistic skills that transfer across languages. Of the three oral language variables investigated here, phonological awareness and grammatical ability tested in English were able to predict reading ability in French. The ability to learn symbol-sound relationships, as assessed by letter-sound knowledge and perhaps also by RAN, likewise appears to be a general skill that transfers across languages. In contrast, English vocabulary, at least as assessed by a receptive vocabulary test, does not seem to reflect a general ability to acquire words that transfers across languages. Working memory measures involving active manipulation and storage of information show promise in predicting reading comprehension across languages.

Predicting Reading Outcomes

English reading. The children in our study were expected to acquire good English reading skills in addition to their French reading skills, and so it is important also to be able to predict those

who are likely to have difficulty with first-language reading acquisition in programs such as French immersion that promote biliteracy. Our findings regarding the variables that predicted French immersion children's English reading development were largely consistent with those of previous studies of monolingual English children, despite the fact that our participants were receiving much of their schooling in French. Along with the observation that mean Grade 3 English reading scores were above the mean on tests norms, this suggests that concurrently learning to read in French did not alter the course of English reading development.

Four of the kindergarten tests—phonological awareness, RAN, nonverbal IQ, and word identification—were especially good predictors of Grade 3 English reading ability, as combinations of these four measures appeared in the best models for word identification, word fluency, passage rate, and passage accuracy. A fifth measure, grammatical ability, appeared only in the best model of reading comprehension, where it was a powerful predictor of Grade 3 English reading comprehension scores. Best models, which included just two to four of these predictors, accounted for a quarter of the variance in Grade 3 English word reading fluency scores; over one third of the variance in word identification, passage rate, and passage accuracy scores; and over half the variance in reading comprehension scores. Vocabulary, digit span, pseudoword repetition, letter-name, and letter-sound knowledge did not appear in any of the best models, indicating that these measures do not provide useful predictive information beyond that provided by the other measures. A possible reason that vocabulary was not included in the best model is that the reading tests may have included words that were well within children's speaking vocabularies at the point at which they reached ceiling performance. If so, then vocabulary may be a stronger predictor of reading comprehension in later grades.

Our investigation of predictors of English reading growth rates revealed that the only significant predictors had negative coefficients, meaning that children with lower scores on the measures had faster growth rates than children with higher scores on the measures. Word identification in kindergarten was the only significant predictor of growth rates in all the best models that had significant variance in slope (i.e., all except for reading comprehension). This finding indicates that the English reading ability of children who read few words in kindergarten approaches that of children who can read more words in kindergarten as they progress through the grades. That is, exposure to formal reading instruction produced a convergence over time in reading scores between students with high and low word identification scores in kindergarten.

French reading. Three of the English kindergarten tests—letter sounds, RAN, and word identification—were especially good predictors of Grade 3 French reading ability. Letter-sound knowledge appeared in the best model for every French reading test, and RAN appeared in all but the model for French reading comprehension. RAN was a particularly good predictor of speeded reading. English word identification appeared as a predictor of the intercepts for passage reading rate and comprehension and was a significant predictor of slopes for word reading fluency. As in the analyses of English reading, grammatical ability appeared in the best model of French reading comprehension. In contrast to the results for English reading tests, phonological awareness appeared

in only one best model, that for French word identification. The best models, which contained just two or three of these predictors, accounted for a quarter of the variance in untimed reading measures and a third of the variance in the speeded reading tests. Nonverbal IQ, vocabulary, digit span, pseudoword repetition, and letter-name knowledge did not appear in any of the best models, indicating that these measures do not provide useful predictive information beyond that provided by the other measures.

Our analyses of predictors of French reading growth rates revealed that many of the predictors had positive coefficients, particularly for the passage reading accuracy and comprehension measures, meaning that children with higher scores on the measures had faster growth rates than children with lower scores on the measures. Such measures might be expected to be particularly informative about long-term reading outcomes. Only the strongest of these growth predictors were included in the best models. English letter-sound knowledge was a significant predictor of growth in French passage reading accuracy, and English grammatical ability was a significant predictor of growth in French passage comprehension. Other predictors of growth were not significant when these predictors of growth were included. Word identification in kindergarten was included as a predictor of growth rates in the best model of French word fluency but had a negative coefficient, indicating that the French word reading fluency of children who read few English words in kindergarten approaches that of children who can read more words in kindergarten as they progress through the grades.

The amount of variance accounted for by best models of French and English reading skills did differ but not by as much as some might expect. The English models accounted for 12.4% and 10.3% more variance than French models of word reading and passage reading accuracy, respectively, but for word reading fluency, the French model actually accounted for 5.9% more variance than the English model, and the amount of variance in passage reading fluency was virtually identical for models in the two languages. The biggest difference in variance accounted for by French and English models was for reading comprehension, where the English model accounted for 33.5% more variance than the French model, primarily because the test of grammatical knowledge was a stronger within- than cross-language predictor. Therefore, testing in a child's first language can provide as good or almost as good predictive information about reading in a second language as reading in the first, except for reading comprehension.

Summary. Our results provide evidence that a battery of English cognitive tests given in kindergarten can do a reasonable job at predicting later reading ability in both English and French in French immersion students. Our results indicate that an efficient battery would include phonological awareness, grammatical ability, RAN, letter-sound knowledge, and word identification. We focused on English predictors of later reading ability because students have little knowledge of French in kindergarten, and therefore French measures are unlikely to be very useful for purposes of early identification. However, there remains considerable unexplained variance in reading outcomes. We are exploring the extent to which the child's ability to acquire French oral skills by the end of Grade 1 can improve on the predictions from English tests.

Limitations and Future Directions

Methodological issues. A reasonable question concerning the results that we have presented here concerns their reliability. One issue is whether the findings would generalize to other participant samples. We conducted the study in nine schools located in three school boards from two provinces in order to decrease the likelihood that our results would be specific to a particular educational context. The schools included public and Catholic schools; schools in urban, suburban, and rural areas; and schools in predominately English communities and a bilingual community. The percentage of the day taught in French also varied across school boards. Although this heterogeneity makes it a challenge to account for large amounts of variance in reading ability with cognitive predictors alone, it does help ensure that the results will generalize to other samples of children. Nonetheless, it is always a good idea for results to be confirmed with a different and larger sample of participants.

A second issue concerns whether the results would generalize with different tests of the abilities that we assessed. With respect to reading tests, we suspect that the findings that are most likely to vary with another measure are those concerning reading comprehension. The field has not yet converged on an ideal way to assess reading comprehension, and until it does, studies like this one will need to be replicated with different reading comprehension tests to see whether a consistent pattern of results is obtained across the tests. With respect to predictor variables, results concerning working memory may be most likely to vary with other measures. Evidence from research by Swanson et al. (2006) suggests that future studies might consider including a working memory measure that is more taxing of working memory than the backward digit span task used here. The pseudoword repetition task that we used from the CTOPP (Wagner et al., 1999) did not turn out to be a good predictor in our study, although it might be worthwhile to take another look at pseudoword repetition using the test developed by Gathercole and Baddeley (1996). Their test may be a more sensitive measure because it has 10 nonwords at each of four lengths (two to five syllables), whereas the CTOPP has only 18 pseudowords in total and only 10 between two and five syllables in length. Masoura and Gathercole (1999) found that 8- to 11-year-old Greek children produced a significant concurrent correlation between scores on a similar pseudoword repetition test with Greek-derived pseudowords and scores on a Greek-English word translation task.

In the present study, we used a test of grammar that assessed knowledge of a variety of grammatical structures, but future research will need to examine more specifically syntactic and morphological knowledge as predictors of later reading ability. Another consideration for future research is whether productive first-language language tasks are better predictors of second-language reading ability than receptive language tasks such as those used here. Furthermore, with respect to vocabulary, there is the question of whether breadth or depth of vocabulary knowledge should be assessed. Tannenbaum, Torgesen, and Wagner (2006) provided evidence that vocabulary breadth (which we assessed) has a stronger relationship to reading comprehension than depth in English-speaking Grade 3 students, but future research will need to explore whether this is also the case when vocabulary is assessed in kindergarten and used as a longitudinal predictor, and when it is

a cross-language predictor. Once researchers have a better understanding of precisely which first-language oral skills predict learning to read in a second language, they can begin to create theories of the mechanisms by which knowledge of a first language facilitates reading development in a second language.

A practical goal of this research was to provide empirical support for a set of measures to identify children who are at risk for reading failure before they begin to learn the language of the school or while their proficiency in that language is still developing. Ten English cognitive predictor variables were investigated in this study, but of course others could have been included as well if testing time was not a factor. Another predictor that could be considered in future research is a measure of children's understanding of print conventions. Levy, Gong, Hessels, Evans, and Jared (2006) provided evidence from English-speaking children that their knowledge of what constitutes readable print was related to early reading skill, even after accounting for variance due to phonological awareness, and Lindsey et al. (2003) found that performance on a Spanish Concepts About Print test accounted for significant unique variance in Grade 1 English word and passage reading.

Sociopolitical context. The sociopolitical context of second-language learning affects a variety of variables that may influence literacy acquisition, such as the child's relative use of each language, the amount of school instruction in each language, and parental educational background. The results of our study with majority-language children were broadly consistent with those of Manis and colleagues (Lindsey et al., 2003; Manis et al., 2004), who tested minority-language children, particularly with respect to cross-language predictors of word identification. This finding suggests that early first-language predictors of second-language reading development are similar across sociopolitical contexts, at least when the two languages involved are alphabetic, although clearly further research is needed to confirm this conjecture. It is important for future research to examine the influence of early predictors on reading development into the later elementary and high school years in each of these contexts because second-language oral competence and reading practice in the second language may become increasingly different in the two types of contexts. In French immersion programs, the children's first language remains their dominant language for both speaking and reading, whereas the second language may become the dominant language for reading and perhaps even for speaking for children from immigrant families. Instruction in school in the first language continues throughout high school for children in French immersion but typically not for children from immigrant families. And finally, amount of exposure to the second language outside school may also differ in the two contexts. These considerations suggest that greater differences in second-language reading development may be observed between these contexts later in schooling than examined here.

Conclusion

With recent advances in technology making it easier and cheaper to communicate with people from around the world, it is becoming increasingly advantageous to be literate in more than one language. Furthermore, with widespread migration, many individuals need to become literate in a language other than the one

they first learned at home in order to participate fully in their new communities. Research on reading development has only begun to understand the challenges and processes involved when children learn to read in a language that is new to them, and even less is known about how children learn to read in two languages simultaneously. Our study has sought to identify the variables associated with success in learning to read in each of two languages in the hope that the knowledge can contribute to educational practices that will help even more children attain high levels of literacy in two or more languages. Literacy in another language in addition to one's native language not only can have benefits with respect to future employment, but also can open up a child's view to another culture.

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