Cross-Linguistic Transfer of Literacy Skills Between English and French Among Grade 1 and 2 Elementary School Students attending French Immersion Programs

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Abstract

Bilingualism is a common reality for a majority of the world's population (Aronin, & Singleton, 2008). Biliteracy, that is, learning to read in more than one language, is also very common among school-aged children around the world. The situation in Canada is particular in that there are two official languages; English and French. Therefore, in Quebec, and other provinces, many children attend immersion programs where they receive instruction in English and in French. Even though those programs have been implanted in Canada since 1965 (Genesee & Jared, 2008), the scientific literature concerning dual-language education is still in development. The precise impacts of learning to read two languages at the same time and the extent to which learning can be transferred between languages are still unknown. Many correlational studies have shown that reading abilities in L1 are related to those in L2 and thus suggest that cross-linguistic transfer is possible. However, causal evidence of cross-linguistic transfer is still needed to demonstrate whether cross-linguistic transfer is possible and which specific literacy skills are subject to it. More experimental reading intervention research in bilingual education is thus needed to investigate the causal relationships between L1 & L2 development (Genesee & Jared, 2008). Following that line of reasoning, the present study aimed to answer two questions; 1) What are the impacts of a preventative intervention in English on the decoding and spelling skills in French among Grade 1 and Grade 2 at-risk students? 2) Does transfer occur at the level of specific knowledge (i.e. transfer of specific grapheme-phoneme correspondences (GPC)) or at the more general level of process involved in reading (i.e. letter-sound rules generalization)?

In this study, participating schools were assigned to one of three experimental conditions (Grade 1: The Direct Mapping and Set-for-Variability (DMSfV), Common or Best Practices (CBP), Classroom-based Support with Curricular and Socio-Emotional Foci (CSF); Grade 2:

Preventative Intervention based on the "Simplicity Principle" (PIbSP), Preventative Intervention Oriented Towards Vocabulary (PIOTV), Classroom-based Support with Curricular and Socio-Emotional Foci (CSF)). Grade 1 (n = 99) and Grade 2 (n = 52) at-risk students (i.e. readers who scored below the 30th percentile in a word reading measure in English) in each condition participated to small-group instruction sessions in English, typically for 12 hours over 10 weeks. Students' word reading skills (irregular words, regular words and non-words) were measured in English and in French, before and after the intervention. Results of the hierarchical linear modeling (HLM) analyses provided evidence of cross-linguistic transfer from midtest to post-test between English and French in Grade 1 for multiple reading outcomes. Analysis of the types of errors made also suggested that cross-linguistic transfer occurred generally more at the process level (decoding mechanisms) rather than with specific GPC knowledge. In Grade 2, however, no significant evidence of cross-linguistic transfer was found.

This study suggests that cross-linguistic transfer is possible, at least among young at-risk readers in Grade 1. Thus, the adoption of teaching practices and educational policies supporting cross-linguistic transfer seem essential in dual language contexts. Nonetheless, more intervention research is needed to understand what aspects of language and learning transfer, and in which context.

Keywords: reading, intervention, cross-linguistic transfer, phonics, at-risk students

Résumé

Le bilinguisme est maintenant un phénomène commun à l'échelle mondiale (Aronin, & Singleton, 2008). Aussi, de plus en plus d'enfants à travers le monde apprennent maintenant à lire plus d'une langue. En ce sens, la situation du Canada est particulière puisqu'il existe deux langues officielles ; le français et l'anglais. Ainsi, au Québec et dans les autres provinces, plusieurs enfants sont inscrits à des programmes d'immersions, à l'intérieur desquels ils reçoivent un enseignement en anglais et en français. Malgré le fait que ces programmes aient été mis en place depuis plusieurs années (Genesee & Jared, 2008), la littérature scientifique est toujours en développement en ce qui concerne l'éducation bilingue. Les impacts précis de l'enseignement de la lecture en deux langues et la mesure dans laquelle les apprentissages peuvent être transférés sont encore inconnus. Plusieurs recherches corrélationnelles ont démontré que les habiletés de lecture en langue première sont reliées de façon importante aux mêmes habiletés en langue seconde. Ces résultats suggèrent donc que le transfert interlangue est possible. Cependant, des preuves causales de l'existence de ce type de transfert sont encore nécessaires. En effet, la littérature scientifique ne permet pas encore de savoir si ce transfert existe et si oui, quelles habiletés spécifiques de lecture et d'écriture sont davantage sujettes au transfert. Ainsi, la présente recherche a tenté de répondre à deux principales questions de recherche : 1) Quels sont les impacts d'une intervention préventive en anglais sur les habiletés de lecture et d'écriture en français d'élèves à risque de 1re et de 2e années ? 2) Est-ce que ce transfert apparaît au niveau de connaissances spécifiques telles les correspondances graphèmes-phonèmes ou encore à un niveau plus général en lien avec la mécanique cognitive associée au décodage?

Dans le cadre de cette étude, les écoles participantes ont aléatoirement été assignées à l'une des trois conditions expérimentales (1ere année: The Direct Mapping and Set-for-

Variability (DMSfV), Common or Best Practices (CBP), Classroom-based Support with Curricular and Socio-Emotional Foci (CSF); 2e année: Preventative Intervention based on the "Simplicity Principle" (PIbSP), Preventative Intervention Oriented Towards Vocabulary (PIOTV), Classroom-based Support with Curricular and Socio-Emotional Foci (CSF)). Les élèves à risque (i.e. lecteurs ayant performé sous le 30e percentile lors d'une épreuve de lecture de mots en anglais) de 1re (*n* = 99) et de 2e année (*n* = 52) de chaque condition ont participé à des séances rééducatives de 30 minutes en anglais. Au total, ces élèves ont reçu environ 12h d'intervention réparties sur 10 semaines. Les habiletés de lecture et d'écriture de mots isolés (irréguliers, réguliers, non-mots) ont été mesurées chez les élèves en anglais et en français, avant et après l'intervention préventive. Les résultats de l'analyse de modélisation linéaire hiérarchique ont démontré la présence de transfert de l'anglais au français pour plusieurs des mesures entre le mid-test et le post-test en 1re année. Des analyses concernant le type d'erreur des élèves semblent également démontrer que le transfert est davantage visible lorsqu'il est question des processus de décodage plutôt que lorsqu'il est question de correspondances graphème-phonème spécifiques. Enfin, en 2e année, aucune trace de transfert entre langues n'a pu être observée.

Cette étude suggère que le transfert inter- langue est possible, et cela, même chez de jeunes lecteurs à risque de 1re année. Ainsi, l'adoption de pratiques pédagogiques et de politiques éducationnelles orientées vers le support du transfert interlangue semble essentielle dans un contexte d'enseignement bilingue. Toutefois, de nombreuses autres recherches expérimentales sont nécessaires afin de comprendre quelles habiletés de lecture et d'écriture se transfèrent d'une langue à l'autre et dans quel contexte.

Mots-clés : littératie, intervention, transfert, identification et production de mots, élèves à risque.

Acknowledgments

Quote: The journey matters more than the destination

This dissertation represents the outcome of an adventure that started six years ago. An adventure with significant challenges, that I sometimes thought would never end, but which brought me a lot, both personally and professionally. I am grateful and proud to have successfully completed such a major project. It would however not have been possible to complete this doctoral degree without the help of so many people.

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Contributions of Authors

This thesis is my original work. As the primary author of this dissertation, I conceptualized the study (including the selection of instruments, research questions and data analyses), as well as wrote the current dissertation in its entirety. My doctoral supervisor, Dr. Robert Savage, has served in an advisory capacity during the conceptualization of this study, formulation of the research questions, data analysis, and writing of the dissertation. This thesis represents a unique contribution to the scientific literature related to cross-linguistic transfer and reading development. As one of the first matched intervention study to investigate cross-linguistic transfer in multiple reading outcomes among at-risk students, it provides unique information concerning cross-linguistic transfer from L1 to L2 in the context of bilingual education (French Immersion programs) and in the particular linguistic context of Quebec.

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Chapter 1: Introduction

Statement of Problem

It is now widely accepted that a certain level of reading and writing is essential to succeed in modern society, even though it constitutes a challenge for many children. Moreover, nowadays, many people face the need to learn their mother tongue as well as one or even two additional languages (Aronin & Singleton, 2008, Genesee, 2004). Learning two or more languages is now characteristic of a majority of persons in the world (Aronin & Singleton, 2008; Roberts, Christo, & Shefelbine, 2011). As a result, a significant proportion of children around the world now either learn to read a second language or learn to read in their second language (Bialystok, Luk, & Kwan, 2005; Genesee, 2008; Lallier, Acha, & Carreiras, 2016; McBride-Chang, 2004; UNESCO, 2003), a phenomenon characterized by the terms biliteracy or multiliteracy. Thus, in addition to learning to read in their first language, children around the world must now face a second important challenge; that of learning to speak, read, and write, in a second language.

In this regard, the special case of Canada, where English and French are the two official languages, is particularly interesting. Since 1965, a variety of bilingual and French Immersion programs (ranging from 100% to 50% French instruction) have been implemented in many elementary schools (Genesee & Jared, 2008). In 2009-2010, more than 328 000 Canadian students were attending immersion programs (Cummins, 2009; Statistique Canada, 2011). In 2000, in the province of Quebec, 22% of the students population attended such programs (Statistique Canada, 2008). Even though French and English are the two official languages, English is predominant across Canada (majority language) and is the language of communication in most homes and workplace. However, in Quebec, French is the predominant language.

Despite the fact that it is an important social phenomenon, a lot of questions are still unanswered regarding the impact of learning to read and write a second language or in a second language. One of the most important questions being asked is if it constitutes an additional risk factor for children. Up to now, many studies suggested that immersion programs do not put children at greater risk of academic difficulties or failure, even for students experiencing academic difficulties (Bruck, 1985; Genesee, 1976, 1978; Genesee & Jared, 2008; Snow, 2008).

Likewise, the concept of transfer of learning and more precisely, the concept of cross-linguistic transfer is inherent to the question of second language literacy learning. Indeed, children enrolled in bilingual programs have to learn to read and write two languages in the same amount of time children in monolingual programs learn only one language. The amount of knowledge that needs to be taught in both languages exceeds the one that can actually be taught in school (Kohnen, Nickels, & Coltheart, 2010). This suggests that children transfer- to some extent- what they have learned in one language when learning a second one. This transfer hypothesis is supported in the scientific literature by many studies affirming that L1 influences the learning of an L2 when learning to read (Snow, 2008). Indeed, research findings do show that phonological awareness, word reading, spelling, vocabulary and reading comprehension in first language (L1) are correlated with the same ability in second language (L2) learning, and that those correlations vary depending on the similarities between languages (Snow, 2008).

However, researchers agree that biliteracy has received insufficient attention (Snow, 2008; Lallier et al., 2016; Verhoeven, 2011) and many questions are still unanswered. Partly because the study of second language reading is qualified as challenging (Koda, 2012b; Snow, 2008), the large majority of studies investigating cross-linguistic transfer are cross-sectional and correlational (Genesee, Geva, Dressler, & Kamil, 2008; Koda, 2012a; Snow, 2008). Thus, the

potential influence of a first language when learning a second language has been suggested, but no causal relationships can be inferred from those correlational studies. As a result, alternative explanations to transfer (e.g., the impact of second language instruction) cannot be ruled out (Snow, 2008). For instance, the impact of second language instruction or simply the better general abilities of certain students could explain the influence of L1 on L2. Therefore, stronger proofs of the existence of direct transfer between two languages are needed. Hence, the need for longitudinal and more importantly, intervention studies has been emphasized by several researchers (Deacon & Cain, 2011; Genesee et al., 2008; Genesee & Jared, 2008; Koda, 2012b; Snow, 2008). There exist few longitudinal studies of L2 literacy development, but intervention studies concerning transfer from L1 to L2 are almost non-existent in the literature (Genesee & Jared, 2008). Many authors also mention that experimental intervention studies regarding French Immersion students with difficulties in learning to read remain insufficient in the literature (Genesee, 2007; Genesee & Jared, 2008). Indeed, struggling students are often the ones that are less able to transfer their knowledge but that would need it most (Péladeau, Forget , & Gagné, 2005). Moreover, assuming that transfer does happen when learning to read in two languages, questions also remain as to what exactly is transferred, in which circumstances it is transferred and what the cognitive mechanisms responsible for this phenomenon might be. Indeed, there exist few models of L2 development, let alone ones that address L2 reading development or transfer of learning. In this regard, Snow (2008), mentions that few studies addressed the existence, role or strength of transfer in L2 development.

In principle, conducting experimental intervention research would help to establish causal relationships between the teaching of a certain skill in L1 and its transfer to L2. Indeed, a certain skill would be taught in L1 to an experimental group of students and their performance on a

related L2 skill would be compared with that of a control group of students who would not have received the L1 intervention.

Presentation of the Present Research Project

Thus, the main objective of the present research is to use an experimental design to investigate the transfer of reading and spelling skills between English and French among first and second grade students enrolled in French Immersion programs in Quebec. It also aims to analyze the development of those skills over a school year for at-risk students.

This study would be the first intervention research to address cross-linguistic transfer of word reading and spelling skills among at-risk and normally developing readers. As such, it could have many valuable impacts. First, it would broaden the scientific literature by providing strong causal evidence of transfer between English and French, which was never obtained before. In fact, findings could confirm the results of the many correlational studies done in the same domain. Furthermore, analyses could provide novel information as to what extent knowledge in L1 transfers to L2 and in which circumstances. Lastly, the results of this study would help determine if transfer happens at the level of specific knowledge (i.e., transfer of specific grapheme-phoneme correspondences (GPC)) or at the more general level of process (e.g., letter-sound rules generalization).

Answers to these questions are important since they could have important educational implications. In fact, they could provide guidance regarding the best educational interventions (Kohnen et al., 2010) for typical as well as at-risk and struggling students. Moreover, it is of utmost importance that immersion and bilingual programs provide optimal instruction of early literacy skills to second-language learners, in order to prevent the development of literacy

problems (Verhoeven, 2011). It would also provide important information that could inform second language learning policies.

Outline of the Next Chapters

The next chapter will constitute a theoretical framework regarding second language learning and cross-linguistic transfer. First, the definition of the central concept of this research project will be presented. Then, models of reading development as well as second language learning theories and hypotheses will be examined. Subsequently, empirical evidence regarding cross-linguistic transfer and second language learning will be reviewed. The research questions and hypotheses of this study will also be outlined in more detail. Lastly, the methodology section will detail the sample, the intervention, the measures and the planned analyses.

Chapter 2: Literature Review

Part I: Concept of Transfer

The concept of transfer of learning has been studied by psychologists for more than a century and represents one of the ultimate goals of teaching and learning that most educational institutions aspire to (Day & Goldstone, 2012). However, transfer is a concept for which it is possible to find the widest range of opposing views at both conceptual and empirical levels (Barnett & Ceci, 2002; Day & Goldstone, 2012; Schwartz, Bransford, & Sears, 2005). In fact, some authors affirm that meaningful transfer is rare (Bransford, Brown, & Cocking, 2000; Haskell, 2001; Nokes, 2009; Perkins & Salomon, 2012) whereas others characterize it as very common or ubiquitous (Chi & VanLehn, 2012; Dufresne, Mestre, Thaden-Koch, Gerace, & Leonard, 2005). Also, definitions vary across authors and theories (Butler, 2010). Several different taxonomies can also be found in the literature (Barnett & Ceci, 2005; Haskell, 2001) that differentiate between the content that is being transferred and the context in which it is being transferred, or both. While researchers generally agree that transfer is the use of previous knowledge in new situations, there is little other consensus on the topic (Barnett & Ceci, 2002; Lobato, 2012).

Various perspectives on transfer. Many different views of transfer exist in the literature. The classical perspective of transfer is commonly associated with the idea of using prior elements of knowledge in a new context or situation (Barnett & Ceci, 2002; Bransford & Schwartz, 1999; Day & Goldstone, 2012). According to this view, the learning situation and the transfer situation must share common elements in order for previous knowledge to be used in a new situation (Thorndike, 1901). It follows that the more elements the two situations have in common, the greater the probability will be for high transfer. Transfer is thus often characterized

in terms of "distance", that is to say the relative amount of similarities, between the learning task and the transfer task. Transfer can thus be near or far, depending on whether the tasks share many similarities or only few (see Barnett & Ceci, 2002, for a classification of nine dimensions of far transfer). The classical perspectives have been criticized for ignoring motivational and contextual aspects of transfer both in their definition and in the assessment of transfer (see Nokes-Malach & Mestre, 2013, for a review of the main criticisms).

More recent perspectives of transfer such as the "preparation for future learning" theory (Bransford & Schwartz, 1999; Schwartz & Martin, 2004) and the "actor-oriented perspective" (Lobato, 2003; 2012) aimed to broaden the definition of transfer and the ways to assess it. Both approaches integrate motivational and environmental factors in their definition of transfer and promote a more qualitative evaluation of transfer. They are in favor of a more authentic evaluation of transfer rather than more often artificial laboratory experiments. For instance, the goal of the "actor-oriented" perspective is not to assess if transfer occurs or not, but rather to investigate the whats, hows and whys of transfer. Also, Nokes-Malach and Mestre's (2013) "transfer as sense-making" theory promotes an ecological view of transfer by integrating motivational, social and ecological aspects of a situation to the cognitive mechanisms associated to transfer. Their model is very promising and integrates aspects of several different views of transfer, notably the cognitive focus of the classical perspective and the consideration for motivational and environmental aspects found in the more recent perspectives such as "preparation for future learning".

Across theories, many factors have also been considered to have a great impact on transfer. Some of the most important ones are: retention of information (Butler, 2010), deep understanding and expertise in a domain (Nokes, 2009; Chi & VanLehn, 2012), cognitive load

(van Merriënboer & Sweller, 2004), and metacognition (Bransford et al., 2000; De Corte, 2003). Students' attitudes and motivations (Perkins & Salomon, 2012) as well as teaching methods (Schwartz, Chase, & Bransford, 2012) also need to be considered as playing an important role regarding transfer.

Cross-linguistic transfer. In the biliteracy literature, however, the concept of transfer is seldom defined in detail and the existence of controversy surrounding the definition and measurement of transfer is often not explicitly acknowledged by researchers. Also, theories and empirical results from the transfer literature are very rarely used to interpret the results of studies interested in cross-linguistic transfer. In addition, unlike the general concept of transfer, controversy relatively to cross-linguistic transfer is not explicitly reported in the literature and definitions of the concept are rarely discussed in empirical studies about biliteracy. Therefore, some researchers view the term "transfer" as a term lacking scientific precision (Kuo & Anderson, 2010). The term generally has a very broad definition and is often used to describe any studies interested in the relationships between learning a first and a second language. It is generally considered as the positive (or negative) influence of one language on another (Kuo & Anderson, 2010) and more precisely as the conscious or unconscious use of previous knowledge in one language when using another language. Koda (2009) recently summarized two points of view that can be found in the literature. First, cross-linguistic transfer can be considered as the reliance on first-language knowledge when second-language knowledge is not sufficiently developed. According to Koda this view suggests that the object of transfer is linguistic knowledge (i.e., set of rules) and that transfer is expected to cease when second-language proficiency is attained. Applied to reading development, this view suggests that students would, for example, apply English rules to decode words in French. The second point of view reported

by Koda presumes that cross-linguistic transfer is the automatic activation of first-language knowledge, triggered by second-language input. Automaticity in L1 is thus a prerequisite for transfer to L2. Also, in this latter view, form-function relationships (i.e. relationships between features of the written language) are expected to be transferred, rather than a set of fixed rules. Thus, it is the activation of an L1 response to a L2 stimulus that is considered as transfer. Applied to reading development, this view suggests any automated reading process in L1 could be applied and thus transferred to L2. Therefore, in opposition to the first view, transfer is not expected to cease at any given point in time in L2 development. However, the two views may not be irreconcilable. Cross-linguistic transfer of specific rules might happen, as well as transfer of form-function relationships. These might just be different forms of transfer, happening at different moments in L2 development. Within this study, both views of transfer will be considered.

In sum, the general concept of transfer has been and is still the subject of many controversies in the scientific literature. Many definitions and views of the concept exist and the cognitive processes and mechanisms underlying this phenomenon are still under research. Controversies around the concept of cross-linguistic transfer are somewhat less salient in the literature. However, this does not mean that very precise definitions are available. General descriptions of the concept are often used, but what cross-linguistic transfer is, and how it occurs seems to be current issues (Koda, 2009). One could also say that definitions of this concept ignore motivational and ecological factors related to transfer. Future studies will thus need to address these questions in order to provide a stronger basis to research in that domain.

Part II: Theories of Learning to Read

During the past decades, many theories of reading development have been presented in the scientific literature. Most of them relate to monolingual or first language reading development or skilled reading. They outline the major developmental phases of learning to read for children (Ehri, 2000; Seymour, 2007) or detail the cognitive processes involved in skilled reading (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Seidenberg & McClelland, 1989). However, the interaction between two languages as well as the impact of other factors (e.g., age of exposure to second language), are unique to second language reading. Thus, from a theoretical point of view, models of monolingual reading may not be sufficient to address second language issues properly (Koda, 2012a). Nevertheless, learning to read in a second language or learning to read a second language may not be totally different than learning to read a L1, especially in the case of English and French since they are in some senses (i.e. alphabet, cognates, phonemes, etc.), similar. L1 models could thus still constitute a basis to study L2 reading development but that approach is not consistently seen in the literature. On the contrary, in the scientific literature, L1 reading models and empirical findings are seldom used to explain L2 reading phenomenon. Building on existing theories, however, seems like the logical way to advance scientific knowledge. It thus appears necessary to use both first and second language theories to guide research in this domain. Therefore, because first language reading acquisition is not at the center of this research project but is still closely linked to second language reading acquisition, a brief overview of the most relevant models will first be provided in this section. Then, second language acquisition theories will be presented.

L1 reading theories. The multiple reading models that exist in the literature vary in the aspects of reading they explain. There are theories that aim to model all processes involved in

reading comprehension (e.g. Laplante, 2011) and theories that focus on certain specific processes such as word reading. Given the focus on decoding in the intervention studies around which this work is nested, the following section will primarily consider theories associated with word reading. In the last decades, two main models of word reading development have been competing in the literature; the dual-route cascaded model (DRC) (Coltheart et al., 2001) and the triangle model (Seidenberg & McClelland, 1989). Both are psycholinguistic theories and computational models that aim to model the cognitive processes involved in word reading, one of the first skills that need to be acquired by elementary school students.

Dual-route cascaded model. First, the dual-route cascaded model (Coltheart et al., 2001) is based on the assumption that two main cognitive mechanisms or routes are involved in the identification of words: a lexical route and a nonlexical or sublexical route. The lexical route represents the mechanism by which readers can recognize known words by sight, without recourse to phonological mediation. It thus provides a direct pathway from the written form of the word to its phonological and/or semantic representation. This route is therefore the only route capable of accurately reading exception words that do not follow letter-sound rules and that cannot be "sounded out" (e.g., pint, the). Fluent readers also use this route to read all words stored in the mental lexicon since it is faster than the nonlexical route. Also, because this route is based on a mental representation of words, pseudowords (e.g. "blick) – that have never been seen before – cannot be read accordingly through this route. Pseudowords (or nonwords) are orthographically legal invented words that are phonologically plausible in one language, but that have no semantic representation. They are thus not stored in the mental lexicon and needs to be read through the other mechanism: the nonlexical route. This second main route is the process whereby readers can identify written regular words or pseudowords using letter-sound

knowledge and grapheme-phoneme correspondences (knowledge of the mapping between a letter (e.g., “b”) or a combination of letters (e.g., “ea”, “sh”) and their sounds). The reader can thus “sound out” words or nonwords by associating each letter or grapheme with its corresponding phoneme. A phonological representation is thereby produced and the word can be pronounced and possibly linked to a semantic representation. Lastly, although two main routes are usually associated with that model, the lexical route can be subdivided in two routes: lexical nonsemantic (orthography to phonology) and lexical semantic (orthography to semantic to phonology). While the lexical nonsemantic and non-lexical routes have been formally modeled, the lexical semantic route, however, has not yet been implemented in a computational model,

Triangle model. The triangle model (Seidenberg & McClelland, 1989) also contains a lexical and a nonlexical pathway to word reading. One of the main differences with the dual-route model is that it explicitly links the nonlexical route to the semantic representation of words, suggesting that decoding words with the help of letter-sound knowledge will activate a semantic representation of the word, as much as the lexical route. This link is not explicit in the dual-route model. Another important difference to the dual-route model is that there are no “local” word representations in the triangle model, since there is no distinct lexical route. Word representations are thought to be distributed, meaning that each word corresponds to a unique pattern of activation of the different phonological, orthographic and semantic units of the cognitive system and each of those units play a role in the representation of numerous words.

Both models advance a connectionist view of reading, in the broad sense of using connected networks of sublexical units where inputs cause patterns of activation and inhibition across representations that alter the strengths or ‘weights’ among all units. However, the nature and content of the two models’ network differ markedly as well as their computational modeling.

The dual-route model is based on McClelland and Rumelhart's (1981) work on the interactive activation and competition model (IAC) and puts forward a cascade model of activation using feature, letter and word-level representations. In addition, the architecture of the model is predetermined by the researchers, rather than developed by a learning algorithm as for the triangle model. Also, in the latter, there are typically letter-cluster units of onset-rime (e.g. s-at, br-ead) or onset-peak-coda (e.g. s-a-t, br-ea-d) representations but no feature or word-level representations. Nevertheless, both models can be associated with behaviorist theories of learning.

Neither model has considered L2 acquisition, but focus on L1 skilled reading. Nevertheless, the concepts of transfer of learning or generalization have been discussed in association with connectionism (Gasser, 1990). Indeed, once a pattern of association is learned, the presentation of a new pattern, similar to the first one, will tend to activate the former one, thus increasing chances for transfer. In their review of computational modeling in developmental psychology, Plunkett, Karmiloff-Smith, Bates, Elman and Johnson (1997) also mention that "connectionist networks are analogy machines" (p. 57) and that their "responses to novel stimuli reflect the similarity of the new inputs to those on which the network has already been trained". (p. 57). This is in line with the classical view of transfer, which suggests that common elements are necessary for transfer to take place.

Developmental models. All theories presented before are interested in the cognitive processes involved in skilled reading. However, other theories are developmental in nature and aim to explain how children come to skilled reading. Several authors have presented stage or phase theories of learning to read (Chall, 1983; Ehri, 1999; Frith, 1986; Seymour, 1986) that segment reading development in two to four developmental stages or phases. Some of those

stages are very similar across theories while others are different. Since long-term development and developmental phases in L1 are not the focus of the present research, it would not be relevant to give a full description of all those theories (see Ehri, 2005, for a review of developmental models). However, two of those models may be more relevant to this project. First, Seymour's (1986, 2007, 2008) dual foundation model was built to account for reading development in multiple alphabetical languages. It might thus be relevant to interpret reading development in a biliterate educational context. The model also is now often used in the literature and several empirical studies support it. It is particularly explicit on processes and also assumes two routes are necessary for visual word recognition. Second, because it is one of the central theories cited in the literature nowadays, Ehri's (1999) phase model needs to be considered. Her model portrays the successive quantitative and qualitative changes in word reading through development. Such a model could be useful in interpreting bilingual students' errors and successes when reading and spelling words. A brief overview of both models will be provided below.

Dual foundation model. Seymour's model is divided into four distinct phases. Phase 0 (letter-sound knowledge) is characterized by the learning of the letters of the alphabet as well as their links with sounds, which constitute an indispensable prerequisite for reading. Phase 1 (foundation literacy) corresponds to the development of two parallel but independent foundation processes (routes) of word reading; the logographic and the alphabetic processes. In this model, the logographic process is required for familiar sight word recognition and storage (e.g., exception and irregular words, frequent words) whereas the alphabetic process is required for the sequential decoding of a word with the help of letter-sound knowledge. Seymour mentions that the logographic process develops only in languages whose spelling exceeds a certain level of

transparency (i.e., one grapheme corresponds to only one phoneme), which is the case for English and French. Indeed, in both orthographic systems, one grapheme can be mapped to multiple phonemes and one phoneme can be written with multiple graphemes. Then, during phase 2 (orthographic literacy), orthographic knowledge is acquired and representations of legitimate orthographic forms of monosyllables are formed. Knowledge is structured around linguistic specific units such as onset-rime. Lastly, phase 3 (morphographic literacy) is characterized by the development of a system of representation of complex words constituted of complex syllables and morphemes (Seymour, 2005; 2008). The morphological structure of words is then taken into account when reading words.

Seymour (2007, 2008) mentions that the syllabic structure (simple or complex) and the orthographic depth (e.g., transparent or opaque relationship between graphemes and phonemes) of a language are determinants for each developmental phase. Educational factors (e.g., teaching methods) are also considered to have an important impact on reading development. However, even though the model has considered reading development across many European languages (Seymour et al., 2003), it does not consider L2 reading acquisition or cross-linguistic transfer. Nonetheless, considering both the fact that L1 is correlated to L2 and that there seems to be more transfer when languages are similar (Snow, 2008), it is possible to hypothesize, on the basis of Seymour's L1 theory, that reading development in a L2 might be similar to the one in L1 but that cross-linguistic transfer might accelerate development in L2, especially if similarities can be found in both foundation processes (i.e. logographic and alphabetic). Accordingly, it could be hypothesized that less transfer would be observed between languages that share similarities only in one of these two foundation processes.

Phase theory of sight word reading. Ehri's model (1999) portrays the development of sight word reading in a succession of qualitatively four distinct phases. In each phase, the model describes the key reading processes and skills that emerge, change and develop. First, during the pre-alphabetic phase, reading is carried out on the basis of visual or contextual cues. Because they lack alphabetical knowledge, children at this phase do not use letter names or sounds to convert graphemes into phonemes. Rather, they remember words by remembering contextual or visual cues such as the general shape of a certain letter or the specific location where they usually see the word (e.g. name tag on a locker). Second, the partial alphabetic phase is characterized by the acquisition of letter knowledge and the use of this knowledge as well as phonemic awareness skills (i.e. phoneme segmentation and parsing) to read parts of words, hence the name of the phase. Thus, readers at this stage are thought to read by using phonetic cues, meaning that they use letter-sound knowledge to convert some graphemes and then, with the help of their phonemic awareness skills (i.e. phoneme segmentation and parsing), find a word in their mental lexicon that matches the letters they converted to sound. Third, the full alphabetic phase corresponds to the moment readers develop a more complete knowledge of grapheme-phoneme relations as well as full phonemic awareness skills (i.e. phoneme segmentation and parsing) and use them to decode new words or nonwords. They stop confusing similarly spelled words and are able to convert unfamiliar words to familiar ones after reading them a few times. Lastly, the consolidated alphabetic phase arises when the predominant types of connections for retaining words in memory are morphographic. Readers at that phase can decode unfamiliar words and nonwords proficiently and use larger units such as affixes, onset and rimes to read words. As with other L1 theories, Ehri's model does not explore cross-linguistic transfer. However, her way of describing the qualitative changes in sight word representation and reading

across development provides an interesting framework to explore students' reading skills in multiple languages.

Self-teaching hypothesis. First, Share's (1995) "self-teaching hypothesis" proposes that even though explicit teaching of reading is required, independent reading can lead to successful phonological recoding (decoding) of novel letter strings and thereby, to the acquisition of word-specific orthographic information. Learners are thus thought to generalize previous print-to-sound knowledge or strategies in order to successfully decode new words or letter strings. For second-language reading, this theory suggests that children could generalize print-to-sound knowledge or strategies acquired in one language to successfully decode words in another language. However, there exist no empirical studies testing the self-teaching hypothesis relative to transfer of learning, or for second-language acquisition. Several empirical studies of L1 reading support the idea that independent reading supports the acquisition of novel orthographic information (Bowey & Muller, 2005; Cunningham, 2006; Share, 2004). However, Nation, Angell and Castles (2007) demonstrated that even though phonological recoding is related to orthographic learning, the relationship is not visible at an item-by-item level. Indeed, their research shows that accurate decoding predicts orthographic learning across items, but that when taking each item independently, accurate decoding does not always predict orthographic learning, and even less so when taking into account variation across participants. They therefore suggest that self-teaching does lead to orthographic learning but that other factors are also involved in that aspect of reading development.

Simplicity principle. While all previous models focus on the cognitive processes associated to reading and how these develop, other theories are more concerned with effective teaching methods to foster reading development. Those theories are necessary to bridge the gap

between developmental theories and the implementation of effective reading interventions. One of these is the "simplicity principle" developed by Vousden, Solity and colleagues (Solity & Vousden, 2009; Vousden, Ellefson, Solity & Chater, 2011). Their theory draws upon the previously mentioned developmental models and uses them to identify the best way to organize reading instruction to increase learning and generalization. Therefore, based on a statistical analysis of words frequency in children's books, the authors identified the most important words and GPCs (knowledge of the mapping between a letter (e.g., "b") or a combination of letters (e.g., "ea", "sh") and their sounds) children need to learn in order to successfully decode the highest proportion of words in texts. Thus, the "simplicity principle" builds on a dual route idea (i.e. reading of sight words and decoding words by using GPCs), but shares with connectionist models the statistical analysis of the spelling system. Thus, after analyzing 685 contemporary children's books, Solity and Vousden (2009) found that the 100 most frequent English words account for approximately 50% of all word tokens whereas the next 50 most frequent words account for a significantly lower proportion of word tokens in children's books. Similarly, they found that teaching 64 GPCs (out of 461 in English; Gontijo, Gontijo, & Shillcock, 2003) would enable children to read more than 60% of all word types in children's books. Therefore, the authors advocate that teaching an optimal amount of information, that is to say the most frequent elements (i.e., high-frequency words and grapheme-phoneme correspondences), will lead to maximum generalization. The aim of such teaching is to draw children's attention to the most frequent and important elements for word reading. Thus, reducing the amount of information to memorize should increase the retention of those important elements and lead to an optimal performance in reading, as well as to generalization. The "simplicity principle" thus provides a clear and testable framework to test and measure transfer of learning. One could, however,

criticize the fact that this theory does not address the semantic aspects involved in word reading. Other models and interventions are thus probably necessary to complement this one.

Set-for-variability. All reading developmental theories concede the fact that, in many alphabetical languages such as English and French, it is not possible to learn to read proficiently by using only phonological and letter-sound knowledge. Irregular words such as "was" or "do" or inconsistent graphemes that can be converted to multiple phonemes such as "ea" or "ow" cannot be read solely on the basis of basic letter-sound knowledge. Theories such as the triangle model (Seidenberg & McClelland, 1989) suggest that the combination of phonological information and semantic knowledge is thus necessary to successfully read irregular words. This conceptual knowledge about reading led to the development of instructional techniques encouraging children to combine their phonological knowledge to the use a semantic strategy to successfully decode words. When taught this strategy, children are encouraged to link a decoded chain of GPCs to a known word in their lexicon. The use of such strategy has often been referred to as "set-for-variability" (Elbro & de Jong, 2017; Gibson, 1965; Tunmer & Chapman, 2012; Venezky, 1999) in relation to the flexible state of mind in which the reader has to be in order to derive the adequate pronunciation of a word. This type of strategy has been used in two different contexts in the scientific literature. First, some research suggests that "set-for-variability" is useful only when reading irregular or mispronounced words (Dyson, Best, Solity, & Hulme, 2016; Tunmer & Chapman, 2012; Zipke, 2016). In such studies, students are taught to try and match mispronounced or irregularly spelled words to words in their lexicon. For example, if reading /wəs/ when decoding the word "was", children are encouraged to try and match this chain of phonemes to a known word in their lexicon that sounds similar and that, if read in context, makes sense with the rest of the text. Other research rather suggests educators teach a

"set-for-variability" strategy to help children read multiple types of words (Elbro & de Jong, 2017; Steacy, Elleman, Lovett, & Compton, 2016). For example, in order to help them decode words with variable vowels pronunciation, intervention studies have taught children to try out the different possible sound of the vowel and find which pronunciation led to a known word. For example, when having to read "low", one could either read /lʊ/ (as in "loud") or /laʊ/ (as in low) and then decide which one matched a known word. It is, however, also possible that the 'set-for-variability' strategy is helpful even for reading regular words with consistent vowels because the products of phonic analysis – the 'spelling pronunciation' are still not the same as the stored lexical pronunciation (Elbro & de Jong, 2017). Obviously, in all contexts, the use of such strategy may also rely on students' vocabulary knowledge (Tunmer & Chapman, 2012). The fewer words are stored in the mental lexicon, the less possibility there is for the set-for-variability strategy to be effective. This strategy is based on the teaching of one element that students can generalize and use to read multiple words. It thus also provides an interesting context to study transfer of learning. Clearly, a "set-for-variability" strategy is, however, not sufficient to learn to read proficiently and should be taught in combination with phonics for students to successfully learn to read. More research is needed in that matter to determine what role such strategy plays in proficient reading and how its teaching influences students' reading development.

In conclusion, first-language literacy skills have been widely studied and theories of word reading are now reasonably well developed. Even though they differ on certain critical aspects, there is still consensus on some elements. For example, all theories consider the phonological and orthographic aspects of a word and acknowledge the importance of word frequency in learning. However, the question remains as to which specific cognitive processes underlie skilled

reading and spelling. Still, the precise information gathered through numerous years of research about the development, the nature and the optimal teaching methods of literacy skills can support the development of hypotheses for L2 literacy learning in alphabetical orthographies. For example, one could presume that when learning to read a second language, children will go through similar developmental phases and thus will need to acquire phonological, orthographic as well as semantic information about words. It could also be hypothesized that more frequent words will be read faster than words that are rare, as is the case in L1 reading. However, what L1 theories do not provide is information about how the knowledge of a language influences the learning of a second one. It would be illogical to think that knowledge of one language does not influence the learning of a second one. How it influences it, though, is the issue that needs to be addressed by L2 reading theories.

Part III: Theories of Cross-Linguistic Transfer

Theories of cross-linguistic transfer. Even though cross-linguistic transfer of reading skills has been studied for a certain time, no precise theory explains how reading skills developed in L1 influence the development of reading skills in another language (Koda, 2012a). Nevertheless, research on bilingualism has led to the development of theories of second language learning, which can be applied to reading. The most relevant theories regarding this research project will first be presented: The developmental interdependence hypotheses (Cummins, 1979, 1991) and the structural sensitivity hypothesis (Kuo & Anderson, 2010). Lastly, a brief overview of other theories of L2 learning somewhat less related to the present research project will be presented.

Developmental interdependence hypothesis (DIH). The work of James Cummins is certainly one of the most cited in the bilingual and biliteracy literature (Koda, 2012a). The

developmental interdependence hypothesis suggests that: “the level of L2 competence which a bilingual child attains is partially a function of the type of competence the child has developed in L1 at the time when intensive exposure to L2 begins” (Cummins, 1979, p. 233). Cummins specifies that the amount and adequacy of L2 exposure as well as the motivation of the child to learn the second language should also be taken into account to explain L2 proficiency. Basically, according to the author, well-developed L1 skills (e.g. letter sound knowledge in English) make transfer possible and thus constitute the basis for the development of the same skills in L2 (e.g. letter sound knowledge in French). However, a child who has very good skills in English word reading could perform poorly in French word reading if he or she had very little exposure to French (e.g. 30 minutes per month) or if he or she was not motivated to learn that language. At first, the hypothesis only predicted transfer from L1 to L2 but Cummins later concluded that a reciprocal relationship was possible. Acquired L2 skills can thus positively influence L1 skills if instruction and motivation levels are adequate (Cummins, 1981).

According to Cummins, the most logical and plausible explanation of developmental interdependence between two languages is that there is a set of non language-specific capacities that supports language development and that, once developed in one language, these capacities are available to support the development of academic language in another language, including literacy skills.

Cummins (1979) distinguishes two types of language proficiency: Basic Interpersonal Communicative Skills (BICS) and Cognitive/Academic Language Skills (CALP). The BICS refer to oral language competences that are necessary to have an ordinary conversation and are considered as the “surface” skills of language. On the other hand, the CALP are the skills that underlie any academic performance and that go beyond the surface level of a language.

Therefore, problem-solving skills and, of more interest here, literacy skills are considered as part of the academic proficiency (Cummins, 1979, Verhoeven, 1994). Thus, the following prediction can be made on the basis of the interdependence hypothesis: Reading instruction in one language supports the development of literacy skills in that language and also has an impact on a set of underlying non language-specific capacities, which in turn promotes the development of academic skills in another language. Cummins's hypothesis is thus used to justify why students learning two languages do not fall behind despite the fact that they receive fewer hours of instruction in both languages than monolingual children do (Cummins, 2005).

A range of assumptions can be drawn from the DIH. First, a child experiencing difficulties in relation to any of those non language-specific capacities should demonstrate the same difficulties in an L2. For example, a child having difficulty to memorize letter sounds in English should experience the same difficulty in French. The same assumption could be made regarding academically strong students. For example, a child who would find it easy to segment the sound of his or her first language should not, to a certain extent, experience too much difficulty doing the same task in his second language.

The DIH is supported by many elements in the literature (Cummins, 2005). Several studies have demonstrated high correlations between L1 and L2 reading skills (Cummins, 1979, 2005; Verhoeven, 1994). Indeed, the cross-linguistic relationships between L1 and L2 literacy skills have been established in the literature for many skills such as phonological awareness (e.g., Bialystok et al., 2005; Comeau, Cormier, Grandmaison, & Lacroix, 1999; Chiappe & Siegel, 1999; Kruk & Reynolds, 2012; Snow, 2008), decoding (e.g., Bialystok, McBride-Chang, & Luk, 2005; Genesee et al., 2008) or orthographic processing (Deacon, Chen, Luo, & Ramirez, 2013; Deacon, Wade-Woolley, & Kirby, 2009). Even though those correlations are usually stronger

between more similar languages, correlations concerning certain linguistic skills (i.e., reading strategies) are still significant across languages that do not share many similarities, such as French and Chinese (Snow, 2008). However, more research is needed in order to clarify the connections between languages as well as the concept of "common underlying proficiency" (Koda, 2012a). Precise measures of specific literacy skills are necessary to determine what exactly are those non language-specific capacities that support reading development in many languages.

Nonetheless, Cummins hypothesis has been the subject of a number of criticisms. First, Genesee (1984) mentioned that social factors should be taken into account in Cummins work instead of only linguistic and cognitive factors. One could also mention that Cummins' hypothesis does not address the concepts of majority and minority languages and how learning a majority or a minority language as a L2 can influence cross-linguistic transfer . Also, Verhoeven (1994) mentions that the inclusion and broad description of conditions of exposure and motivation in the interdependence hypothesis makes it hard to test empirically. In this regard, as mentioned in the introduction, because studies investigating cross-linguistic transfer are predominantly cross-sectional and correlational (Genesee et al., 2008; Koda, 2012a; Snow, 2008), more intervention studies are needed in order to provide causal proof supporting the existence of cross-linguistic transfer and thus the DIH.

Structural sensitivity theory. Much research has shown that bilingualism or immersion programs enhance metalinguistic abilities (Bialystok, Majumder, & Martin, 2003; Bruck & Genesee, 1995; Kovelman, Baker, & Petito, 2008; Wagner, Torgesen, & Rashotte, 1994). Thus, studies suggest that exposure to more than one language improves children's word awareness (Cummins, 1978, Ricciardelli, 1992) and phonological awareness (Bialystok et al., 2003; Bruck

& Genesee, 1995; Chen et al., 2004) when compared to children learning only one language. These authors often use the term “bilingual facilitation” to refer to that phenomenon.

Based on the work of other researchers, Kuo and Anderson (2010) recently developed their own theory of bilingual facilitation, which they preferred to name ‘structural sensitivity’. They note that: “the bilingual advantage in structural sensitivity may arise from a constant need to overcome inter-lingual interference, which focuses children’s attention on the structural features of language” (Kuo & Anderson, 2010, p. 369). Therefore, because they are exposed to certain linguistic elements in richer contexts that may render similarities and differences between languages more salient, bilingual students would form representations of language structure at a more abstract level. More specifically, the theory specifies that the degree of bilingual effect is influenced by the extent to which two languages share elements (e.g., alphabet, phonemes, orthography). Indeed, the presence of many similarities between languages (e.g., similar phonemes) would lead to the formation of better-specified internal representations of the shared elements between languages, which would be harder to accomplish with languages sharing few similarities. Although they do not deny the existence of cross-linguistic transfer, Kuo and Anderson argue that bilingual facilitation goes beyond the simple carry-over of processing skills from one language to the other. Rather, they presume that it is the combined experience with two languages that yields enhanced performance in bilingual children.

Kuo and Anderson (2010) tested this theory at the level of phonological awareness skills. They compared about 200 monolingual and bilingual kindergarten and first grade children in Taiwan, whose dominant language was Mandarin and who where exposed to Southern-Min (i.e. heritage language) at home, on several phonological awareness measures. Onset awareness, rime awareness and tone awareness were measured. Their results show that the development of

phonological awareness is accelerated when children are exposed to two languages and that bilingual children were better able to detect features of novel syllables than monolingual ones, thus supporting the structural sensitivity theory. Other researchers have applied this theory to studies concerning the cross-linguistic transfer of orthographic processing. Indeed, Deacon, Commissaire, Chen, and Pasquarella (2012) wanted to determine if orthographic regularities (legal orthographic patterns) common to both English and French would be better controlled by students than those that exist only in one language, a hypothesis they derived from the structural sensitivity theory. They tested 80 Grade 1 children on orthographic decisions tasks at the lexical and sublexical levels. Their results showed that children did demonstrate greater skills with orthographic patterns that were legal in both languages (shared patterns) (e.g., "oin", "age", "fl") than with the ones that were legal in only one language (unique to each language) (e.g., "oeur" in French and "ough" in English). It is thus possible to hypothesize that cross-linguistic transfer is greater for linguistic elements (e.g., GPC, orthographic patterns) that are common between languages, than for those that are unique to one language.

Additional theories of L2 learning. Other theories of L2 learning are also present in the literature. First, Cummins's "linguistic threshold hypothesis" (Cummins, 1979) holds that the level of L2 proficiency mediates the transfer from L1 to L2. Thus, a lack of proficiency in either L1 or L2 will lead to inadequate reading in L2. Also, the "orthographic distance hypothesis" (Birch, 2011) advances the idea that the degree to which L1 and L2 orthography employ the same grain size and mapping details impacts L2 reading. Grain size refers to the way a language's phonology connects with written symbols (orthography). Thus, in some orthographic systems, each written symbol represents a word (larger grain size) whereas in others, written symbols represent syllables or phonemes (smaller grain size). On the other hand, mapping is the

correspondence between the visual symbols and the phonemes or vice versa of each language. The mapping between the visual symbols used to represent phonemes can either be consistent (i.e. one grapheme always maps to the same phoneme and vice versa) or inconsistent (i.e. one grapheme may map to multiple phonemes and vice versa). Therefore, the "orthographic distance hypothesis" assumes that the more mapping details the orthographies have in common, the more chances there is for transfer to happen. Lastly, Perfetti et al. (2007) have conducted brain activation studies in order to evaluate if L2 triggered an assimilation mechanism (cognitive processing used in L1 is used as is in L2) or an accommodation mechanism (adaptation of the cognitive processing to read L2). The results of their empirical studies seem to demonstrate both mechanisms would be involved when reading an L2 (Liu, Perfetti, & Wang, 2006).

In sum, the DIH is a more general theory of cross-linguistic transfer that is used to explain how the knowledge of one language can impact on the learning of a second one. On the other hand, the structural sensitivity theory is more specific in that it aims to determine the impact of bilingualism on specific cognitive processing (e.g., phonological awareness). More precisely, it aims to identify how bilingualism modifies the cognitive processing of linguistic elements. However, while the influence of L1 on L2 and thus the DIH has been supported by many empirical studies, few research studies have tried to determine – like the structural sensitivity theory – what are the specific changes in cognitive processing when learning a second language and what exactly is transferred between languages. All those questions can easily be transposed to the study of L2 reading research. Thus, more research is needed in that matter in order to design more effective reading interventions for bilingual students as well as to develop more precise and complete models of cross-linguistic transfer of reading skills. In this regard, it seems only logical to suggest that elements of L1 reading theories and transfer models should be

acknowledged and considered when developing models or conducting research in the domains of biliteracy and cross-linguistic transfer. Indeed, the several years of research about transfer of learning and monolingual reading skills may constitute a good starting point for the development of L2 reading theories.

Part IV: Empirical Evidence of Cross-linguistic Transfer

Because of the increase in the number of people around the world learning a second language (Aronin & Singleton, 2008; Roberts, Christo, & Shefelbine, 2011), and specifically children learning to read in a second language, research on second language learning has become both more voluminous and more sophisticated (Koda, 2012a). However, according to several researchers, generalization and transfer of learning related to literacy skills in a second language have not received enough attention and are still under researched (Koda, 2012b; Kohnen et al., 2010; Snow, 2008).

Reviewing the empirical work regarding the issue of cross-linguistic transfer is not a simple task. Understanding the development of literacy skills in a L1 being complex enough as it is, adding a second language to the mix and trying to understand how they interact adds to the complexity of the review. Still, the next section aims to provide an overview of the empirical research regarding the development of specific literacy skills in a second language.

Phonological awareness. First, one of the most important linguistic skills children need to acquire when they enter school is phonological awareness. Simply stated, it refers to the capacity to detect and manipulate the sounds of a language. Some of those manipulations involve identifying, comparing, segmenting or combining speech sounds that occur within a language. In L1 research, phonological awareness skills are deemed to be one of the most predictive factors of

reading achievement in first grade in alphabetical languages (Snow, Burn, & Griffin, 1998). Studies have also shown that the same applies in L2. Indeed, not only are phonological awareness skills good predictors of early reading skills in second-language learners (e.g. Lesaux & Siegel, 2003), a study by Geva and Siegel (2000) suggests they can even be better predictors than oral proficiency skills.

Empirical research studies suggest that phonological awareness skills are strongly related between languages (Chen et al., 2004; Bialystok et al., 2003; Bialystok, McBride-Chang et al., 2005; Comeau et al., 1999; Chiappe & Siegel, 1999; Kruk & Reynolds, 2012; Wade-Woolley & Geva, 2000; Snow, 2008). Indeed, results of those studies show high correlations between L1 and L2 phonological awareness skills, whether the two languages are similar as, for example, English and French (Bialystok et al., 2003; Chiappe & Siegel, 1999; Comeau et al., 1999; Kruk & Reynolds, 2012) or dissimilar, for example, English and Chinese (Bialystok, McBride-Chang, et al., 2005; Chen et al., 2004; Wade-Woolley & Geva, 2000; Wang, Park, & Lee, 2006). Therefore, in the scientific literature, phonological awareness is considered as a language-general as opposed to a language-specific capacity and its transfer between languages is expected. Comeau et al. (1999) also showed that phonological awareness skills in English (L1) can be used to predict performance on the same skills in French (L2) (Comeau et al., 1999). In addition, Kruk and Reynolds (2012) demonstrated that typically developing and at-risk students in immersion programs had superior phonological awareness abilities at the end of Grade 3 than their monolingual (English program) peers, thus supporting the "bilingual facilitation" hypotheses as well as the claim that immersion programs can be beneficial for literacy development.

As mentioned earlier, no causal relationships can be drawn from correlational studies. In order to demonstrate that a causal link exists between language development in L1 and that in

L2, experimental intervention studies are required. When searching for such studies in several databases (i.e. ERIC, EBSCO, PsycINFO, Scopus), only two experimental intervention studies investigating cross-linguistic transfer of phonological awareness were found. They are described below.

First, Goodrich, Lonigan and Farver (2013) conducted a study with preschool Spanish-speaking students (n = 94) learning English. For 21 weeks, students were randomly assigned to either the control group or one of the two experimental conditions. The students in the control group were only exposed to the regular classroom curriculum. Students in the experimental conditions, received small group pull-out instruction sessions, based on effective teaching practices related to phonological awareness and print knowledge. Four sessions per week were provided and each one lasted 20 minutes. In one of the experimental conditions, instruction was given in English only (L2), while in the other, the instruction was given in Spanish (L1) for the first 9 weeks and in English (L2) for the remaining weeks (transitional condition). Vocabulary, phonological awareness (phoneme blending and segmenting tasks) and print knowledge were measured before and after the interventions. Results show that students in both experimental conditions scored higher than children in the control group on English (L2) measures at post-test. However, only children in the transitional condition scored higher than children in the control condition on Spanish measures (L1) at post-test. This finding shows that the intervention in English only was not sufficient to promote cross-linguistic transfer. The DIH predicts that improvement in one language (either L1 or L2) should lead to improvement in the other language, but it was not the case here. An intervention in English led to improvement in English (L2) but not in L1 (Spanish), a fact that the authors have difficulty explaining. Would L2 be less influential on L1 than the opposite? Findings also demonstrated that children with greater ability

in one language benefitted more from instruction in that language than children with lower skills, providing support for Cummins's "threshold hypothesis". Overall, the authors claim that their results support the transfer of phonological awareness skills, but the validity of the results is questionable. Indeed, the fact that instruction was given in both languages in the transitional condition makes it very difficult to investigate cross-linguistic transfer. Also, the regression analyses did not provide specific information about transfer. For instance, the study does not indicate if transfer was more important for blending or segmenting tasks.

Second, Wise, D'Angelo, and Chen (2015) conducted an experimental study with at-risk Grade 1 students attending French Immersion programs. Participants were assigned to either an experimental group (n = 5) or a control group (n = 7). At-risk students in the experimental group participated in small-group interventions in Grade 1 and their phonological and word awareness skills were assessed from Grade 1 to Grade 3. Grade 1 children in the experimental group (n = 5) participated in small-group intervention sessions and were provided with phonological awareness training in combination letter-sound correspondence instruction. In this training, instruction about the concepts of sentences, words, and syllables was delivered. However, most of the instructional time was devoted to manipulating (i.e. blending and segmenting) phonemes in words. Those words were taken out of children's books that were read to students during each session. Texts were selected based on the presence of words allowing the teaching of specific phonological awareness skills. On the other hand, students in the control group (n = 7) participated in vocabulary-building small-group intervention. In both conditions, two 25 minutes small-group sessions took place each week, for 18 weeks. All small-group interventions were conducted in English by the first author, who was also the special education teacher at the school. Their results indicated that following the small-group intervention, at-risk students in the

experimental group performed significantly better than the control group at post-test on measures of phonological awareness, when controlling for pretest abilities. This difference, however, was not significant when children reached Grade 3. Nonetheless, in Grade 3, a significant difference between groups was found in relation to French phonological awareness. The same was observed for word reading. Authors concluded that explicit phonological awareness training in English can lead to cross-linguistic transfer in French over time. The small sample is one important limit of this study. The fact that French phonological awareness was not measured at pretest also limits the analysis of cross-linguistic transfer following the intervention. The improvement of the experimental group two years later could be due to other instructional or environmental factors.

In sum, even though several correlational studies led to the conclusion that phonological awareness skills transfer between languages, stronger causal proofs of transfer are needed from intervention studies. Also, many questions, which could not be addressed by correlational studies, remain unanswered regarding the specificity, the nature and the interpretation of that transfer. For example, the impact of phonological awareness training in L1 on at-risk and not at-risk students' phonological skills in L2 is still unknown (Genesee et al., 2008). Also, the impact of each phonological awareness skill in L1 (e.g., blending, segmenting) on the development of the same skills in L2 and the extent to which each of those skill transfer depending on the L1 and L2 characteristics is unknown and evidence on this question could guide instructional decisions. Furthermore, as suggested by Kuo and Anderson's (2010) research, empirical studies must investigate the specific changes occurring in cognitive processing and mental representations when learning a second language as well as what exactly is transferred between languages.

Decoding. Decoding refers to the ability to transform printed letters into speech sounds (Perfetti, 1985) and it is without a doubt a fundamental aspect of reading ability regardless of the

language being learned. Indeed, as proposed in the Simple View of Reading (Gough, & Tunmer, 1986), decoding and listening comprehension are the two key foundational aspects of reading comprehension. In addition, the factors that account for the most variance in reading comprehension are word-reading accuracy and speed (Perfetti, 1985). Experiencing difficulty in decoding words is thus an important risk factor and is predictive of academic difficulties (Torgesen, 2000). Given its importance in reading development, decoding has been the subject of countless studies in L1 acquisition.

One of the most common ways to teach decoding skills is phonics instruction. Phonics programs involve the explicit and direct instruction of GPCs and blending skills in order to teach students how to "sound-out" words. Many empirical studies as well as some meta-analysis and systematic reviews have demonstrated that phonics instruction was beneficial to reading development and can significantly improve early reading skills in L1 (Ehri, Nunes, Stahl, & Willows, 2001; McArthur et al., 2012) and L2 (Linan-Thompson, Vaughn, Hickman, Davis, & Kouzekanani, 2003; Stuart, 2004). Also, graphemic (rather than whole word) representations have been identified as the most efficient way to encode information about print to sound relationships (Vousden et al., 2011) and to foster generalization. Indeed, a single GPC (i.e., the letter "b" corresponds to the phoneme /b/) can be used and generalized to decode many words whereas the knowledge of a single whole word (i.e., "was") is more difficult to transfer to read other words. Thus, teaching phonics seems to be the best method to support learning and transfer of reading knowledge.

However, the optimal length and content of phonics instruction is still unclear in the literature. The work of Solity and colleagues on the "simplicity principle" aims to guide instructional decisions on the subject. Indeed, as presented earlier, the authors suggest that

teaching the 64 most frequent GPCs would allow children to read a significant proportion of words in children's, as well as adults' books. Recently, Chen and Savage (2014) conducted a randomized control trial to evaluate the impact of phonics instruction based on the "simplicity principle" on the reading performance of Grade 2 at-risk students (n = 18). Their results show that students in the experimental group performed significantly better at post-test than the ones in the control group, suggesting that the "simplicity principle" reflects optimal phonics instruction. However, to date, those results have only been explored in an L1 context. Still, effective teaching methods and efficient information encoding in memory are considered as factors that can have a significant impact on transfer. It can thus be hypothesized that the "simplicity principle", by supporting the explicit teaching of the most useful linguistic elements could play a positive role in transfer of learning. Based on the DIH, more effective L1 learning should also be beneficial for L2 learning. Savage, Georgiou, Parrila, & Maiorino (2017), in a larger pan-Canadian experimental intervention study aiming to provide support to at-risk students from Kindergarten to Grade 4 replicated Chen and Savage's intervention with Grade 2 bilingual students. Such a study with a larger sample provides an interesting theoretical and methodological context to explore cross-linguistic transfer. It is this specific research context that is used in the present thesis as a framework for exploring transfer to French L2. The details of this study follow later in the thesis.

Automatic and accurate word reading is also essential for second-language readers (Roberts et al., 2011). Accordingly, word reading and decoding is the subject of many studies in second language reading, and Koda (2012b) affirmed that there is more research on decoding than on any other L2 reading ability. Several studies have addressed the decoding ability of second language learners and showed that the development of those students' literacy skills is

very similar to the one of native-language learners (Lesaux, Koda, Siegel, & Shanahan, 2006; Lesaux, Siegel, & Rupp, 2007; Shanahan, & Beck, 2006). As in L1, L2 phonological awareness, L2 letter-knowledge and L2 sound-symbol correspondence rules are predictive of L2 decoding skills (Erdos, Genesee, Savage, & Haigh, 2010; Lesaux et al., 2006). Also, the proportion of children experiencing difficulties in decoding is not higher in second language learners than in native-language learners (Chiappe & Siegel, 1999; Wade-Woolley & Siegel, 1997). In terms of effective teaching methods, research show that L2 beginning readers can develop word reading skills that are equivalent to those of native-language learners if they receive sufficient phonics instruction (Geva & Siegel, 2000; Lesaux & Siegel, 2003). However, most of these studies focus on language-minority students learning to read English as a second language and who are educated in English. Therefore, those studies assess the L2 reading ability of students receiving instruction only or mostly in L2. Thus, they generally do not provide information about cross-linguistic transfer.

The research of Lallier et al. (2016), however, investigated the influence of an L2 on L1 reading. The authors compared the word reading skills of French-Basque and Spanish-Basque bilingual Grade 2 students. Their results suggest that the orthographic properties (i.e. opacity) of an L2 influence the word reading strategies used in L1. Thus, children learning to read an opaque L2 (i.e. French) developed larger grain size word reading strategies and relied on larger orthographic units (e.g. consonant clusters) when decoding words in both languages, even though their L1 was transparent (i.e. Basque). On the contrary, children learning two transparent orthographies (i.e. Spanish-Basque) relied on small grain strategies. Thus, those results suggest that word reading strategies transfer between languages and the nature of the language pairs may differently influence the development of specific reading subskills.

Research that assessed both L1 and L2 and that explicitly investigated transfer of learning are somewhat less numerous in the literature. Two points of view can be identified regarding the transfer of decoding skills. First, some authors (Abu-Rabia, 1997; Bialystok, McBride-Chang, et al., 2005; Da Fontoura & Siegel, 1995) have claimed that decoding draws on language-specific processes (e.g., orthography) and that, as a consequence, it is not subject to transfer. On the other hand, many studies have demonstrated that bilinguals are better at word reading than monolinguals (Genesee & Jared, 2008) and that word reading in L1 is positively correlated with that of L2 (Abu-Rabia, 1997; Da Fontoura & Siegel, 1995; Snow, 2008; Wade-Wooley & Geva, 2000). In addition, empirical studies show that good L1 readers are usually good readers in L2 and that struggling readers in L1 usually experience difficulties in reading in L2 as well (Dressler & Kamil, 2006; Genesee et al., 2008), thus providing support to the DIH. The existence of a relationship between L1 and L2 decoding skills has therefore been demonstrated many times.

Research findings suggest that similarities between languages can explain this variance in the results of the different studies (Koda, 2012b; Melby-Lervåg & Lervåg; 2011; Snow, 2008), meaning that cross-linguistic transfer of decoding skills is more important when languages are similar (e.g., languages sharing the same alphabet) than when they are very different (e.g., languages with different writing systems such as Chinese and English). Indeed, in a recent meta-analysis, Melby-Lervåg and Lervåg (2011) identified factors that could explain the variations in the amount of transfer observed in research studying cross-linguistic transfer of decoding skills. Their results identified two significant moderators to the correlation between decoding skills in L1 and L2: instructional language and closeness of the writing system. Thus, correlations between L1 and L2 decoding skills were higher in studies in which students were instructed both in L1 and L2 and in which the two writing systems were similar. This is in line with classical

theories of transfer according to which the learning situation and the transfer situation must share common elements in order for transfer to take place (Thorndike & Woodworth, 1901). In the Canadian immersion programs, students are often instructed in both English and French and both languages' writing systems are quite similar (see p.61 for a detailed analysis). It can therefore be hypothesized that there is a greater probability of cross-linguistic transfer in that context.

Lastly, research also demonstrated that L1 phonological awareness is correlated with and can predict L2 word reading (Bialystok, McBride-Chang, et al., 2005; Erdos et al., 2010; Genesee et al., 2008; Wade-Wooley, & Geva, 2000; Wang, Perfetti, & Liu, 2005). However, L2 oral proficiency would not be a significant predictor or an important obstacle to L2 word reading (Geva & Siegle, 2000; Geva, Yaghoub-Zadeh, Schuster; 2000). Indeed, research tends to show that L2 language proficiency has an important impact on reading comprehension (Dressler & Kamil, 2006) but not on word reading (Geva & Siegel, 2000). The ability to decode can be thus assessed adequately even though language proficiency is not fully developed.

In sum, empirical results tend to support the DIH and to show that there is a relationship between L1 and L2 decoding skills and that the strength of this relationship is moderated by the similarities between languages, which is in line with the classical theories of transfer. This implies that decoding skills are not completely language-specific and that cross-linguistic transfer is likely to be observed, at least for similar languages such as English and French. However, as mentioned before, all the available information about transfer of decoding skills is based on correlational data and does not provide strong proof of transfer or specific information about what is transferred between languages (Koda, 2012a). Therefore, more intervention research studies are needed to provide stronger proofs of cross-linguistic transfer and to test the DIH assumption suggesting that improvement in one language can lead to improvement in

another language (i.e. from L1 to L2 and vice versa). Such studies are also required to determine if transfer happens at the level of specific knowledge (i.e., transfer of specific GPCs) or at the more general level of process (i.e., letter-sound rules generalization). For instance, as suggested by the structural sensitivity theory, is there greater transfer for GPCs that are shared by both languages (i.e., transfer of specific knowledge)? or is transfer observable through a general improvement of decoding skills (i.e., transfer at the process level)? Answers to those questions may have an impact on theoretical positions as well as practical implications for L2 learning and teaching.

Spelling. In L1 as well as in L2, reading and spelling skills are highly correlated (Lesaux et al., 2006) and are thought to influence each other (Seymour, 2007). The association between reading and spelling skills is also known to increase as students progress through elementary school (Caravolas, Hulme, & Snowling, 2001). Moreover, according to the self-teaching hypothesis (Share, 1995), orthographic representations, which are necessary to spell words adequately, are thought to develop through reading. Improvement in reading skills is thus thought to lead to improvement in spelling skills and vice versa. Transfer of learning between reading and spelling skills of one language has been the subject of some empirical research and findings show that knowledge does transfer between those two skills (Bosse, Valdois, & Tainturier, 2003; Conrad, 2008; Kohnen et al., 2010; Share, 2004). For instance, in a study by Conrad (2008), one group of Grade 2 students were trained to read words whereas a second group of students were trained to spell those same words. Students in both groups were able to read and spell trained words as well as novel words. Nevertheless, Conrad (2008) and others (Kohnen et al., 2010) have demonstrated that greater transfer can be observed from spelling to reading than from reading to spelling.

However, little is known about cross-linguistic transfer of spelling skills and many authors affirm that more research is needed in that matter (Genesee et al., 2008; Snow, 2008). A review of empirical studies investigating language-minority students suggests that factors affecting spelling performance in L2 are similar to the ones influencing decoding such as phonological awareness skills and letter knowledge (Lesaux et al., 2006). Many of the empirical studies interested in the cross-linguistic transfer of spelling skills focused on transfer from Spanish (L1) to English (L2) and used spelling error analyses to study transfer. Their results show that L1 orthographic knowledge seems to influences L2 spelling when the learner has limited L2 orthographic knowledge (Fashola, Drum, Mayer, & Kang, 1996; Genesee et al., 2008; Snow, 2008). Indeed, Howard, Green, and Arteagoitia (2012) studied spelling error patterns of Spanish students learning English and found that errors based on cross-linguistic transfer (i.e., applying Spanish grapheme-phoneme rules to English) could be observed in Grade 2 students but that this type of error greatly decreased and almost disappeared by Grade 4. According to the authors, this might indicate that students' specific knowledge of each orthography increased with time, thus eliminating the need to use L1 to spell words in L2. Studies using error pattern analyses focus on negative transfer from one language to another, meaning that they are centered only on transfer that led to mistakes. Positive transfer may also be involved in learning how to write two languages. Students may not need to learn the two orthographies separately but may be able to transfer specific elements from one to the other. Accordingly, findings from Ferroli and Shanahan (1992) and Fashola et al. (1996) demonstrate that consonant knowledge is transferred between Spanish and English since both languages use the same Roman alphabet. Results of correlational studies also suggest that L1 and L2 spelling skills may be related (Davis, Carlisle, & Beeman, 1999).

The scientific literature suggests that, as for other literacy skills, the relationship between L1 and L2 spelling skills may be affected by similarities between languages (Dressler & Kamil, 2006). Therefore, the more elements two languages have in common, the greater the probability of transfer. This could explain the results of Arab-Moghaddam and Sénéchal (2001) who found that spelling performance of students learning Persian and English (two different writing systems) were not correlated significantly. In addition, Dressler and Kamil (2008) mentioned that negative transfer, that is transfer leading to an inadequate answer, is expected when the second language presents more complex features than the first language (e.g., Spanish and English). Students use their L1 knowledge of a simpler orthography to spell words in their L2 with a more complex orthography, which leads to inadequate spelling.

The few empirical studies that exist addressing cross-linguistic transfer of spelling skills suggest that there is cross-linguistic transfer between similar languages such as English and French. However, as for the previously presented literacy skills, more experimental research is needed in order to provide stronger proof of transfer, especially to attempt to establish genuinely causal connections in transfer, and to determine what, specifically, transfers between languages.

Children experiencing difficulties. Several research studies have demonstrated that even though second-language learners in immersion programs usually lag behind native-language learners in kindergarten regarding literacy skills, in most cases they catch up or, in some cases, even surpass the performance of native-language learners later in primary grades (Genesee, 2004; Lesaux et al., 2006; Lesaux & Siegel, 2003; Lesaux et al., 2007; Slavin & Cheung, 2005; Verhoeven, 2000). Thus, research shows that immersion programs do not seem to have any negative effect on L1 literacy skills development (Slavin & Cheung, 2005). However, since the implementation of immersion programs, several concerns have been expressed with

regard to the suitability of such programs for at-risk and struggling students (Genesee, 2007). Parents, educators and researchers have been asking if those programs can be detrimental for at-risk or struggling students or if learning two languages can slow down development (Genesee, 2008; Genesee, & Jared, 2008). Unfortunately, to date, little evidence is available to answer those questions (Genesee, 2007; Kruk & Reynolds, 2012). Generally, research show that experiencing difficulties in L1 is a strong predictor of difficulties in L2. For example, Comeau et al. (1999) showed that students experiencing difficulties with phonological awareness in English experienced the same difficulties in French. Many other studies also demonstrated that early predictors of reading and language difficulty in L1 can be used to predict reading difficulty in L2. Such predictors are phonological awareness and letter-sound knowledge (Erdos et al., 2010; Genesee, Savage, Erdos, & Haigh, 2013; Jared, Cormier, Levy, & Wade-Woolley, 2010). In the same vein, Lesaux and Siegel (2003) demonstrated that the performance profile of English-language learners experiencing difficulties learning to read is comparable to that of native-language learners: Both have marked difficulties in phonological awareness and working memory.

Notwithstanding these shared cognitive profiles, some program evaluation studies have shown that at-risk students enrolled in immersion programs perform better than comparable at-risk students in full-time English programs on comprehension measures (Kruk & Reynolds, 2012) and word reading measures (Da Fontoura & Siegel, 1995). Bruck (1985) compared the performance of students with academic difficulties in immersion programs with those of comparable students, who were previously enrolled in immersion but who went back to full-time English programs. Analyses revealed that students who returned to full-time English programs did not improve more on measures of English academic skills ranging from decoding and

reading comprehension to language and mathematics skills than those who stayed in immersion programs. Genesee (1978) also found that below-average immersion students performed significantly better on French reading tests than below-average students in English only programs. Thus, the results of research conducted with below-average students to date suggests that being enrolled in an immersion or bilingual program is not disadvantageous to English academic outcomes (Francis, Lesaux, & August, 2006; Snow, 2008).

Arguably the strongest evidence regarding the impact of French Immersion on students with difficulties in learning to read would come from experimental intervention studies (Genesee, 2007; Genesee & Jared, 2008). It can be argued that such studies are required in order to both gain knowledge about the impact of French Immersion programs and to guide the development of optimal interventions for students enrolled in such programs. In their review, Genesee and Jared (2008) identified only three such candidate research studies, of which only one included a control group. Moreover, none of these studies measured reading ability after the intervention. Thus, at a minimum, future experimental intervention studies need to include control conditions as well as direct measures of reading at pre- and post-intervention stages in order to assess the effectiveness of interventions. As mentioned before, and at a theoretical level, those types of studies would also provide stronger proof of cross-linguistic transfer. Indeed, if a group of students exposed to an intervention about a certain literacy skill in L1 performs better on L2 measures of the same skill than a control group who did not receive the intervention; it will be possible to conclude that there is cross-linguistic transfer. Such results would also constitute a strong evidence of the existence of a causal link between the intervention in L1 and transfer of learning. That kind of research would contribute to creating a virtuous circle of research (Snowling & Hulme, 2011) in the sense that well-designed experimental research would

help to test causal theories and lead to better practices which in turn could help create new theories about dual language reading development. Savage and Cloutier (2017) explicitly identify L2 and cross-linguistic transfer as a research domain where the idea of virtuous circle of research might work well.

Experimental intervention research on students experiencing reading difficulties when learning English as a second language can be found more easily in the literature. In general, studies seem to indicate that features of effective interventions for students experiencing difficulties in their first language are also beneficial for students experiencing difficulties in an L2 (Lesaux & Siegel, 2003; Snow, 2008). For instance, results suggest that effective interventions for ESL learners include explicit teaching of all linguistic and reading knowledge and skills necessary to read (Kamps et al., 2007). Thus, for example, the specific GPCs and sight words necessary to read one language, as well as grammar and vocabulary words need to be taught explicitly to children for optimal learning. Research also shows that small-group settings are effective (Kamps et al., 2007). However, because the interventions assessed in those studies are generally conducted in L2, they do not provide direct information about cross-linguistic transfer. Therefore, there is a need for intervention research exploring the best teaching methods to favor transfer from L1 to L2 in dual language context. To do so, researchers should run an intervention that was proven effective in L1 and then assess its impacts in L2. To allow the investigation of transfer, pre- and post-test assessment, random assignment of participants as well as the presence of a control condition would be necessary.

To this end, Savage, Georgiou, et al. (2017) report the results of a study evaluating the impact of a preventative intervention carried out in English on English reading skills of (n = 197) elementary school students enrolled in French Immersion programs in Quebec and Alberta. The

study presents all of the features of a well-designed study discussed above. The research aimed to determine the value added by small group interventions. Students were assigned to one of two conditions: Common best practices (CBP) or Direct Mapping and Set-for-Variability Intervention (DMSfV). Each group received a total of 11 hours of small-group instruction over 10 weeks, divided in 30-minute sessions. Students' reading skills in English were assessed before and after the intervention as well as at the beginning of the next school year. Using Hierarchical Linear Modeling (HLM) analyses, and taking into account between classroom variation, they showed that at-risk students in the DMSfV experimental condition performed significantly better than students in the CBP group ($p < .05$) on many reading outcomes at post-test (word reading (WRAT) and nonword spelling (Woodcock Johnson Achievement test)) and at delayed post-test (word reading (Wide Range Achievement Test) and sentence comprehension (Group Reading Assessment Diagnostic Evaluation)). Analyses of effect sizes also indicated an advantage for the students in the DMSfV condition across all follow-up measures. Their results thus demonstrate that a preventative supplemental and more intensive effective intervention can indeed help improve at-risk biliterate students' reading skills in L1. However, the impact that this type of intervention has had on French reading proficiency remains to be explored. It is this specific research context that is used in the present thesis as a framework for exploring transfer to French L2. The details of this study follow later in the thesis.

To conclude, more research is needed in order to identify the impact of different factors on reading development of at-risk students enrolled in French Immersion programs. In addition, while research about the transfer in a variety of domains (e.g. mathematics, physics, language, etc.) has demonstrated that transfer is often less observable among at-risk students (Haskell, 2001; Péladeau, Forget, & Gagné, 1999), little is known about those students' ability to transfer

knowledge from L1 to L2 when reading. More research is therefore needed on this matter. Such research would certainly guide educational decisions (Genesee, 2007) and help to offer optimal instruction to at-risk and struggling students. At a theoretical level, such research would also help to build more precise models of cross-linguistic transfer and L2 reading development. To these ends a first study of cross-linguistic transfer that was conducted for this doctoral thesis will be described and situated within the work of Savage, Georgiou, et al. (2017) in the next chapter.

Factors affecting cross-linguistic transfer. In recent decades, research has identified multiple factors influencing reading development in bilingual students. (Koda, 2012b). First, as is the case in monolingual development, the quality of instruction and more specifically the use of explicit teaching are thought to play an important role in L2 development (Bialystok, McBride-Chang et al., 2005; Lesaux & Siegel, 2003). It also seems logical to think that many of the instructional principles used in monolingual instruction are also beneficial for students in bilingual programs (e.g., adapting instruction to students' level or using a balanced approach of literacy teaching) (Snow, 2008). However, limited empirical data is available to support this assumption (Lesaux & Siegel, 2003).

More importantly, many studies have demonstrated that the orthographic characteristics and the complexity of a language have a significant influence on L2 development (Dressler & Kamil, 2008). One of those characteristics is orthographic depth, which refers to the degree of consistency in the grapheme-phoneme mapping of a language. Thus, orthographic systems are often classified as either transparent, meaning that grapheme to phoneme relations are very consistent, or opaque, meaning that the grapheme-phoneme mapping is more inconsistent, including multi-letter graphemes and irregularities (Frost, Katz, & Bentin, 1987). Therefore, some cross-linguistic comparative research has demonstrated that L1 word reading development

takes longer in languages with opaque orthographies compared to those with transparent orthographies (Caravolas, 2005; Harris & Hatano, 1999; Seymour et al., 2003) and the same thus applies for L2 learning with respect to reading: The more complex the orthography, the harder it is for L2 learners to learn to read (Dressler & Kamil, 2008). However, it has been shown that similarities between the written forms of two languages will increase the likelihood of transfer (Snow, 2008). Indeed, as stated by classical theories of transfer, similarities are the basis of the process of transfer and the more similarities there are, the more transfer there should be. In the case of English and French, several authors suggest that the two languages are similar enough to give rise to transfer, notably at the word reading level (Deacon et al., 2009). The next section thus takes a closer look at the linguistic and orthographic similarities and differences between those two languages.

Similarities between English and French. English and French are both considered as having opaque orthographies because the mapping between graphemes (smallest print unit) and phonemes (smallest speech sound unit) is not consistent in either language, albeit usually considered more consistent in French (Seymour et al., 2003). Indeed, whereas the English orthographic system is unequivocally considered opaque (Seymour et al., 2003; Share, 2008), French orthography is the subject of more discussion. Depending on the method to assess orthographic transparency, authors do not classify French in the same category. Seymour et al. (2003) consider that French orthographic depth is similar to the one of English orthography and thus that it is a rather opaque system. Ziegler et al. (2010) arrive at a similar conclusion when comparing languages on the basis of their words' first consonant consistency. On the other hand, Moll, Fussenegger, Willburger, and Landerl (2009) evaluated opacity by comparing vowel consistency across languages, which led them to conclude that French was relatively transparent.

The linguistic element chosen to measure the opacity level of a language thus leads to differing conclusions about the opacity of French (Savage, McBreen, Genesee, Erdos, Haigh, & Nair, 2017). Nonetheless, since several of those analyses lead to the conclusion that French orthography contains inconsistencies and exceptions, it cannot be considered as transparent.

Thus, based on the fact that similarities across languages support transfer (Bialystok, Luk, et al., 2005; Birch, 2011, Dressler & Kamil, 2008; Kuo & Anderson, 2010; Snow, 2008), it is possible to hypothesize that the fact that they are similar in their complexity is in principle more beneficial for transfer than if one language was transparent and the other, opaque. It is also in line with the classical theories of transfer stipulating that the more elements two situations have in common, the greater the probability is for high transfer (Thorndike & Woodworth, 1901). Therefore, the inconsistencies across languages may develop certain skills that are helpful to read both languages but that would not be developed when exposed to a language with a shallow orthography (Kuo & Anderson, 2010). In addition, an analysis of both languages does indicate that their orthographic systems share many similarities, which will be discussed below.

First, many words in English and French have a common etymological origin and are known as cognates (Deacon et al., 2009). Some of those words, such as table or kiwi are written the same and refer to the same concept in both languages. Some other words are not identical but are written in very similar ways: “dentist” (English) and “dentiste” (French) or “development” (English) and “développement” (French). There are also words that do have the same origin but for which the connection is less obvious. For example, “spouse” (English) and “épouse” (French). Lastly, false cognates, which are words that are similar across language but that do not share meaning, can also lead to negative transfer. It is the case of the word “sensible” which in English refers to having or showing good sense but in French, refers to being sensitive. In sum,

cognates represent a possibility for transfer across languages at the word level. However, because it is not the focus of the present research project, they will not be subject to an extensive review.

At the phonological level, 22 phonemes (mainly consonants) are common to English and French (see Table 1). Considering that there are 44 phonemes in English and 36 phonemes in French, more than half are shared.

Table 1

Similarities and Differences Between the Phonemes of English and French

Shared						**Unique to English**				**Unique to French**	
Consonants			**Vowels**			**Consonants**		**Vowels**		**Consonants**	
/p/	**p**en	**p**ain	/ɛ/	m**e**n	f**ê**te	/tʃ/	**ch**ip	/iː/	b**ea**d	/ʀ/	**r**ue
/b/	**b**ig	**b**ain	/a/	f**a**st	**a**vion	/dʒ/	**j**et	/**æ**/	b**a**d		
/t/	**t**en	**t**oi	/u/	b**oo**k	b**ou**t	/h/	**h**at	/**ʌ**/	n**u**t		
/d/	re**d**	**d**ire	/ə/	**a**bov e	requin	/θ/	**th**ing	/**ɒ**/	b**o**d	**Vowels**	
/k/	ca**k**e	**k**oala				/**ð**/	**th**is	/ɔː/	p**aw**	/i/	**i**mage
/g/	**g**et	**g**âteau				/r/	**r**un	/**ʊ**/	g**oo**d	/e/	d**é**
/s/	**s**ee	**s**ac						/**ɪ**/	p**i**t	/ɑ/	gâteau
/z/	**z**oo	**z**èbre						/**ɜ**ː/	b**ir**d	/ɔ/	b**o**l
/ʃ/	**sh**oe	**ch**at						/**eɪ**/	b**ay**	/o/	**eau**
/ʒ/	vi**s**ion	**j**ouet						/**aɪ**/	b**uy**	/y/	j**u**pe
/f/	**f**all	**f**eu						/**ɔɪ**/	b**oy**	/ø/	bl**eu**
/v/	**v**oice	**v**ent						/**aʊ**/	h**ow**	/œ/	fl**eur**
/w/	**w**e	ki**w**i						/**əʊ**/	l**ow**	/ɛ̃/	p**ain**
/j/	**y**es	b**ille**						**/ɪə/**	d**ear**	/ɑ̃/	l**en**t
/m/	**m**e	**m**oi						/**e a/**	h**air**	/ɔ̃/	p**on**t
/n/	**n**o	**n**on								/œ̃/	br**un**
/ɲ/	ri**ng**	vi**gn**e								/ɥ/	**cui**t
/l/	**l**ake	**l**ac									

Second, English and French also share the same Latin alphabet, and thus both languages represent speech sounds using the same letters. The only exception is that diacritical marks are used in French to change the pronunciation of some letters. Those marks are the acute accent (i.e., é), the grave accent (i.e., è), the circumflex accent (i.e., ê) and the cedilla (e.g., ç). However, as mentioned above, the mapping between graphemes and phonemes is not consistent in either language. One phoneme can thus be represented by many graphemes and a single grapheme can be pronounced in multiple ways. For instance, the grapheme "ow" can be pronounced either as /əʊ/ (e.g. low) or /aʊ/ (e.g., how). There are also many exceptions (e.g., pint) and complex rules (e.g., the sound of the grapheme "i" in bite, vs "bit") in the English orthography. According to Gontijo et al. (2003), there are approximately 461 GPCs in the English language. In French, there are about 160 GPCs according to the analyses of Catach (1973). Gontijo et al. (2003) and Catach (1973) however do not use exactly the same method in their calculations, which makes it harder to compare the number of GPCs in each language. In Catach's analysis for example, morphemes are not taken into account whereas in Gontijo et al.'s work, they are. Nonetheless, as mentioned before, in some analyses, the mapping between graphemes and phonemes is more consistent in French than in English (Borgwaldt, Hellwig, & De Groot, 2005; Caravolas, 2005; Ziegler et al. 2010).

The overlap between English and French GPCs is, however, less clear than the one with phonemes. The majority of the graphemes representing consonants can be associated with the same phoneme in English and in French (e.g., "b", "t", "ph"). According to classical transfer theories, those common GPCs should be easily used in both languages, since they will appear in very similar contexts. However, since the vowels are different in the two languages and because there are significantly more GPCs in English than in French, many GPCs are either unique to

English (e.g. aw, ow, ea) or to French (e.g. eu, eau). Based on the structural sensitivity theory (Kuo & Anderson, 2010) and on the classical theories of transfer, it can be assumed that less transfer will be observed for those GPCs that are unique to each language. Indeed, because those GPCs are not shared (or similar) across languages, transfer of learning is not expected to take place. According to the DIH (Cummins, 1979), however, improvement in L1 could lead to general improvement in L2, regardless of whether graphemes are shared or not, due to the presence of underlying non language-specific capacities. Lastly, there are also graphemes that are common to both languages but that do not map to the same phoneme(s) (i.e. heterophonic homographs) in both languages. For instance, the grapheme "ain" is read as two phonemes (e.g., "pain") in English but as one phoneme in French (e.g., "bain"). Also, the graphemes "en" and "an" are both read as one phoneme in French (/ɑ̃/), but are read as two phonemes (/ə n/ and /ɛ n/ respectively) in English. For the purpose of this research, that type of GPC will be referred to as "orthographic neighbour GPC". Because those GPCs are similar (i.e. same letters) and different (i.e. do not map to the same phonemes) at the same time, they might generate interference between languages and create the need for students to develop more precise representations in order to read adequately in both languages. The structural sensitivity theory (Kuo & Anderson, 2010) suggests that bilingual students would thus develop better representations of those GPCs than for the ones unique to each language. Also, according to the classical theories of transfer, negative transfer (i.e., applying previous knowledge when it is not appropriate) could be observed with those "orthographic neighbour GPC" (all heterophonic homographs across languages), since they are more or less similar (identical graphemes that do not map to the same phonemes) in both languages. Children could thus recognize the grapheme when reading L2 and read it the same way as in their L1.

In addition to sharing the same alphabet, letters tend to be combined in the same way in English and French (Deacon et al., 2009). According to Goldman, Content and Frauenfelder (1996), the same four-syllable structures (i.e. CV, VC, CVC, CCV) account for 91% of the syllables in French, and 76.6% of the syllables in English. Even though the frequencies of those four structures are not the same in each language, the fact that they account for more than the majority of structures in each language indicates that transfer is possible. However, the syllabic structure of English is considered to be complex whereas the one of French is simple (Seymour et al., 2003). This is explained by the fact that the predominant syllabic structure in French is consonant-vowel (e.g., ballon, maison), which is considered a simple structure, while in English it is consonant-vowel-consonant (e.g., dog, run, man), which is considered a more complex structure (Goswami, 2010).

Because English and French share many similarities at the structural level, they provide many possibilities for cross-linguistic transfer. A well-designed intervention study with English-French bilingual students, such as the one described in the previous section, might represent a good opportunity to explore the specifics of cross-linguistic transfer. Indeed, such a study could allow a fine-grained analysis of reading in French following an intervention in English. Cross-linguistic transfer of the various similar linguistic elements (e.g. GPCs, phonology) between those languages could be specifically analyzed and might help determine what transfers most between languages.

Part V: Questions and Objectives

In order to build upon the findings of correlational studies and to provide stronger proof of the existence of cross-linguistic transfer, the main objective of this experimental research was to investigate the cross-linguistic impacts of effective reading instruction in English on reading and spelling performance in French among 1st and 2nd grade at-risk students (for whom French is generally not a first language) attending French Immersion programs. The second objective was to answer one of the most fundamental questions in reading transfer research: what is actually transferred between languages? (Koda, 2012a). More precisely, in line with Kuo and Anderson's (2010) "structural sensitivity" theory, this research tried to determine if transfer happens at the level of specific knowledge (i.e., transfer of specific GPCs) or at the more general level of process (i.e., letter-sound rules generalization).

The present study was embedded in Savage, Georgiou, et al.'s (2017) larger pan-Canadian intervention study investigating the impact of small-group reading instruction in English on at-risk bilingual students' reading development in English. As mentioned before, this well-designed intervention study provides an ideal context to study cross-linguistic transfer between English and French. In Grade 1, the small-group intervention based on known effective teaching methods in L1 (i.e. systematic phonics instruction and "set-for-variability") will allow to observe the impact of such intervention on cross-linguistic transfer. Then, the use of the "simplicity principle" for the Grade 2 intervention provides a clear structure (i.e., list of GPCs in order of frequency) for instruction and offers the opportunity to build a very precise and controlled intervention that will allow the measurement of transfer of learning as well as fine-grained analysis of what is transferred. This Grade 2 intervention based on the "simplicity principle" is also a replication of Chen and Savage's (2014) pilot study described earlier. Since

the results showed clear improvement in reading in English for students in the experimental condition, the replication of this intervention provides a great opportunity to study cross-linguistic transfer to French.

The specific research questions that were associated with the previously mentioned objectives of the present study are hereby presented. First, regarding the 1st grade interventions based on the teaching of phonics, a first question was formulated in relation to cross-linguistic transfer:

- Considering the DIH (Cummins, 1979) predicts that skills in one language can positively influence the learning of a second language, what are the impacts of a supplemental and preventative phonics intervention in English on the cross-linguistic transfer of decoding skills in French among at-risk students?

Also, in relation to the question, "What is transferred between languages?" the following question was developed:

- The DIH (Cummins, 1979) suggests that improvement of skills in one language supports and can lead to the improvement of the same skill in a second language. More precisely, Kuo and Anderson's (2010) "structural sensitivity" theory advocates that the need to overcome cognitive conflict when exposed to two languages creates more abstract mental representations of linguistic elements (e.g., GPC). Thus, following a supplemental systematic phonics intervention, does cross-linguistic transfer occur at the level of specific knowledge (i.e., transfer of specific GPCs), or at the more general level of process (i.e., letter-sound rules generalization), or both at the level of specific GPCs and letter-sound rules generalization?

Then, regarding the 2nd grade interventions based on the "simplicity principle", the present research sought the answer to the following question:

- Considering the DIH predicts that skills in one language can positively influence the learning of a second language, what are the impacts of a supplemental and more intensive intervention based on the "simplicity principle" in English on the cross-linguistic transfer of decoding and spelling skills in French among at-risk students?

In line with the second research objective, the other research question related to the Grade 2 intervention was rather related to the exploration of what specifically transfers between languages:

- In relation with the DIH (Cummins, 1979) this research sought to determine whether the acquisition of knowledge regarding specific GPCs in one language leads to improvement in reading GPCs in a second language. More precisely, the "structural sensitivity" theory (Kuo & Anderson, 2010) suggests that the need to overcome cognitive conflict when exposed to two languages creates more abstract mental representations of linguistic elements (e.g., GPC). Therefore, one could hypothesize that cross-linguistic transfer could be more important for GPCs that are common to two languages than for the ones that are unique to each language. Therefore, the second research question that was formulated regarding the intervention in Grade 2 is: Is cross-linguistic transfer more salient for GPCs shared between French and English (i.e., graphemes that map to the same phonemes in both languages) than for "orthographic neighbour GPCs" (i.e., graphemes that do not map to the same phonemes in English and in French) or those that are unique to either language?

Research Hypotheses

For the questions regarding 1st grade students, the following research hypotheses were formulated:

- The DIH suggests that at-risk students exposed to an effective phonics intervention will show more improvement on word reading skills in French than the at-risk students in the control condition at post-test.
- Based on the structural sensitivity theory (Kuo & Anderson, 2010), the interference created by learning two languages should create the need to overcome cognitive conflict and thus support the development of more abstract mental representations of linguistic elements. Therefore, it is hypothesized that transfer will be more evident at the more general level of process (i.e., letter-sound rules generalization) than at the level of specific knowledge (i.e., transfer of specific GPCs) or both at the letter-sound rules generalization and specific GPCs levels.

For the questions regarding 2nd grade students, the following research hypotheses were developed:

- First, the DIH suggests that developing linguistic skills in one language can positively influence the learning of a second language. Moreover, as mentioned earlier, the "simplicity principle" provides a structured framework to effectively teach phonics in Grade 2. In the present research context, since students are exposed to effective instruction, it is hypothesized that at-risk students exposed to the "simplicity principle" supplemental intervention will show more improvement on decoding and spelling skills in French than the at-risk students in the control condition at post-test.

- Based on the structural sensitivity theory (Kuo & Anderson, 2010), it is theorized that the interference created by learning two languages should lead students to develop more abstract representations of the GPCs that are common to both languages. Therefore, it is hypothesized that there will be more transfer on shared GPCs and "orthographic neighbour GPCs" than on GPCs that are unique to either language, when controlling for their frequency. Accordingly, more transfer is expected on shared GPCs than on "orthographic neighbour GPCs", since they are identical in both languages and can be transferred directly, with no adaptation.

Chapter 3: Methodology

Participants

This study is embedded in a larger pan-Canadian study investigating the impact of effective teaching practices in reading in English on the reading performance in English of elementary school students from Kindergarten to Grade 4 (Savage, Georgiou, et al., 2017) in Quebec and Alberta, Canada. Thus, in the 2 provinces,the work of Savage, Georgiou, et al. (2017) was undertaken solely in English. In Quebec, the work was undertaken among students in schools delivering dual language French Immersion instruction, a practice described in more detail below. The pan-Canadian experimental study started with one cohort of Kindergarten students in September 2012 and a second cohort of Kindergarteners integrated the study in September 2013. The portion of this research project that is relevant to this thesis took place in Quebec in the 2014-2015 school year, and involves the students of the second cohort in Grade 1 ($n = 221$) and the students of the first cohort in Grade 2 ($n = 169$) already participating in the larger longitudinal intervention study.

As mentioned before, all participants in the study attended French Immersion programs. In Quebec, Charter of the French Language (Bill 101) (1977) requires all children to be educated in French, except in certain specific situations. Therefore, not all children are allowed to enroll in French Immersion programs in which part of instruction is in English. Eligible students for such programs are those who are residing in Quebec permanently and whose brother, sister, mother or father did the major part of his or her elementary studies in English in Canada. Students with special authorization because of a serious learning disability or a serious family or humanitarian situation can also be educated in English. Lastly, children of persons living in Quebec temporarily to study or work or children of members of the Canadian Armed Forces who are

posted in Quebec may receive a temporary authorization to receive instruction in English. As a result, most children attending French Immersion programs mostly have some English background, whether it is their first language or not. In the present sample, 69.9% of the Grade 1 students and 69.8% of the Grade 2 students spoke English with at least one of their parents. Therefore, English can be viewed as a majority language for most of the students and French, as a minority language.

All French Immersion elementary school programs in Quebec offer dual language instruction to students. The proportion of time allocated to English or French and how both languages are distributed across schedule (e.g. if teaching alternates between L1 and L2 on a day to day or weekly basis for example) however changes from one school to another. Those decisions usually answer a local demand and are not based on any theoretical or empirical evidence. One thing those programs have in common is that they all need to offer at least 50% of instruction time in French. A total of 13 elementary schools participated in this study. Of those schools, nine had a full English program which means approximately two thirds of the day was spent in English and the remaining tier was spent in French, from Kindergarten to Grade 6. Three schools had a mixed program where students spent half of their time in French and the other half in English. Lastly, one school had an immersion program where students were instructed only in French from Kindergarten to Grade 3. The variety of English/French Immersion programs in this study was representative of the diversity of those programs in Quebec.

The students in this thesis research all came from regular public elementary schools in 4 different school boards in the greater region of Montreal. In Grade 1, girls represented 52.5% of the sample, whereas in Grade 2, they represented 46.6% of the sample. The mother's education

level was used as an approximate measure of SES. In Grade 1, 30,1% of participants had a mother with a high school diploma or less,29.1% of participants had a mother with College (i.e. CEGEP) degree and 40.8% had a mother with a University degree. In Grade 2, those proportions were of 35.6% for both cases college and university degrees whereas 28,8% of participants had a mother with a high school diploma or less. As in any bilingual program, participants had different linguistic backgrounds. Home language ranged from only English, to French or to another language while others were exposed to two or even three languages at the same time. In Grade 1, 66% of participants had English as a first language and 19.8% had French as a first language. In Grade 2, English was the first language of 69.5% of participants and French was the first language of 28.7% of participants. For 16.6% of students in Grade 1, and 5.7% of students in Grade 2, the first language was different than English or French. Thus, English represent the first language of most students in the Grade 1 and 2 samples. English can be viewed as a majority language for most of the students and French, as a minority language. Therefore, throughout this thesis, English will be identified as L1 and French as L2, even though the reality is more complex than this simple claim. Indeed, for most of these students, English is a first language and is the language to which they are most exposed (home, school, community). However, French is the majority language in Quebec. Therefore, they are more exposed to French than children in other Canadian provinces and that is even more often the case for participants living outside the island of Montreal. It would not have been possible, considering the time and resource constraints relative to this doctoral work, to conduct a study with sufficient statistical power with only participants with English as L1 and French as L2. Consents from all parents of the students participating in the study were obtained prior to the experimentation.

Design

This study, as well as the larger pan-Canadian study in which it is embedded, is a matched controlled intervention study with a pretest/post-test design. Additionally, in the larger pan-Canadian study, a delayed post-test of English reading skills was carried out at the beginning of each school year following the intervention. To avoid confounds that would be related to any sharing of information between the students in two different experimental conditions in the same school, schools, rather than students, were randomly assigned conditions. Thus, each participating school was randomly assigned to one of three conditions (two experimental and one control), which will be described in detail below. During the randomization process, school size was not controlled for. Therefore, the sub-sample size of each condition is different (see Table 4). In Grade 1 and in Grade 2, students who scored below the 30% on an English word reading measure participated in a small-group intervention relative to reading in English corresponding to the condition to which their school was assigned. Performance in English and French reading and spelling were measured before and after the intervention in order to investigate cross-linguistic transfer.

Procedure

The following section will first present a detailed description of the larger study in which this project is embedded. Indeed, the interventions were first designed and conducted within Savage, Georgiou, et al. (2017) pan-Canadian research. The present study aimed to investigate the impact of those interventions on French reading and spelling skills. Following the detailed description of the interventions, the procedure for evaluating students' reading performance in French will be described.

Interventions in English. The larger experimental study (Savage, Georgiou, et al., 2017), aims to evaluate the impact of effective teaching practices in reading on the reading performance of students from Kindergarten to Grade 4 elementary school students. To evaluate the efficacy of the implemented teaching practices, performance of students in the experimental groups is compared to those of students in a matched control group who are not exposed to the reading interventions. As mentioned before, schools, rather than students, were randomly assigned to one of the three conditions to avoid any confounds that would be related to any sharing of information between the students in two different experimental conditions. Savage, Georgiou, et al. (2017) report good matching of participants on a range of candidate measures; gender, age, parent-reported learning difficulties, mother's education, mother-child and father-child language, vocabulary, pretest attainment and quality of teaching. The research aimed to offer small group intervention sessions to at-risk students to prevent the development of important reading difficulties. In the fall semester of each year of the project, half-day professional development sessions about best teaching practices corresponding to each of Grade 1 and 2 respectively were offered to teachers of the participating schools. Then, in the winter semester of each year, the students most at-risk (students who scored below the 30% on the WRAT English word reading measure) received a specific and more intensive intervention. Students participated either in one of the two intervention conditions or in the "seen" control.

Literacy Assessment Measures in English

Several standardized measures were used to measure students' performance in English. Those measures addressed phonological awareness skills, word reading skills and spelling skills. To assess the overall pedagogical quality of the classroom teaching across the intervention conditions, the standardized measure of Early Language and Literacy Classroom Observation

(Smith, Brady, & Clark-Chiarelli, 2008) was also used to carry out classroom observation in both 1st and 2nd grade. All measures used in Grade 1 and in Grade 2 are described below and the administration schedule is reported in

Table 2 and Table 3, respectively.

Word reading. Word reading was assessed using Wide Range Achievement Test-4 (Wilkinson & Robertson, 2006, word identification subtest blue form). Children were asked to name 15 letters and read from a list of 55 typed lowercase words for a combined word reading maximum score of 70. Discontinuation occurred after 10 consecutive incorrect responses. The Spearman-Brown split-half internal reliability in this sample was $r = .94$.

To further assess the students' word reading skills, 20 words were randomly selected from the first 200 words in the Fry's Instant Word List (Fry, Kress, & Fountoukidis, 2000). The 20 words were printed in 5 rows of 4 words each and were shown to the children one row at a time. Each word correctly read was worth 1 point. The same 20 words were used at pre- and post-test. The Spearman-Brown split-half reliability in this sample was $r = .86$.

Pseudoword reading. To assess students' ability to decode orthographically legal pseudowords (e.g., 'hap', 'mel', 'distrum', 'gradly'), the pseudoword reading task from the Woodcock Johnson III Test of Achievement Form B (Woodcock, McGrew, & Mather, 2001) was used. The initial items required students to identify the sounds of a few single letters; remaining items required the decoding of increasingly complex letter combinations that follow regular patterns in English orthography, but are pseudowords. Discontinuation occurred after the examinee made six consecutive errors. The Spearman-Brown split-half internal reliability in this sample was $r = .96$.

Spelling. The Woodcock Johnson III Test of Achievement Spelling subtest Form B (Woodcock et al., 2001) was used to assess students' spelling skills in English. Children were first asked to write upper or lower case letters (O, T, W, E, R). They then had to write a

lowercase “i”. Lastly, they were asked to write single words to dictation. For each item the examiner first said the word in isolation, and then in a sentence, in which the word was stressed. Finally, the word was said in isolation again. Words could be repeated when needed, but no further help was provided. Testing continued until the examinee made 6 consecutive errors. The Spearman-Brown split half internal reliability in this sample was $r = .83$.

Phonemic segmentation fluency. The Phonemic Segmentation Fluency subtest of DIBELS (Kaminski & Good, 1999) assesses students’ ability to fluently break three- or four-phoneme words into their individual phonemes in one minute. For example, if the RA read ‘ship’, students had to say /sh/ /i/ /p/. Children were given points for any correct sounds in the correct order (e.g., responses ‘shi’-‘p’ or ‘sh’-‘ip’ yielded 2 points). The Spearman-Brown split-half internal reliability in this sample was $r = .96$.

Blending words. The blending words subtest taken from the CTOPP 2 (Wagner, Torgesen, Rashotte, & Pearson, 2013) and was used with Grade 2 students. The test examines children’s ability to blend together sounds to make words. In this task, children listened to a series of parts of words. Their task was to blend the sounds together to produce the words (e.g. ‘sh’-‘e’ to produce ‘she’). Each item is worth 1 point, for a maximum score of 33. In the initial items, students are asked to blend syllables together. In the remaining items, the examinee must blend smaller phoneme units to form a word. The published internal reliability of the CTOPP blending words in nationally representative Canadian samples (Wagner et al., 2013) is $r = .86$, and the published U.S.-standardized norm for CTOPP 2 blending words is $r = .86$.

Segmenting words. The CTOPP2 Pseudoword segmentation (Wagner et al., 2013) was also used to evaluate students’ phonological awareness skills. In the pseudoword segmentation

task, children are given one orally presented pseudoword at a time (e.g. *ne, seb, shuligrage*) and asked first to repeat it and then articulate each phoneme sequentially. For each pseudoword adequately segmented, the examinee gets 1 point, for a maximum score of 31. Items become progressively longer as the test continues. This test was used only with Grade 1 students. The published internal reliability of this tests in nationally representative U.S. samples is $r = .90$.

Classroom Environment

Teaching practices and classroom climate. The *Early Language and Literacy Classroom Observation* (ELLCO) (Smith et al., 2008) is a reliable and valid standardized test that was used to assess the quality of the classroom environment and teachers' literacy practices in both 1st and 2nd grade. It has been used to assess classroom teaching practices in other large scale experimental studies (e.g. Powell, Diamond, Burchinal, & Koehler, 2010). Two observations were undertaken in the school year (i.e., September and May) in order to gather complete information about the classroom environment. The ELLCO assesses teaching practices in relation with five areas: *Classroom Structure and Climate* (CS, classroom climate and management and organization), *Curriculum* (CU, independence in learning and diversity in the classroom), *Language Environment* (LE, discourse quality and vocabulary learning), *Books and Reading* (BR, resources and phonic, fluency, and comprehension strategy teaching), and *Print and writing* (PW, writing instruction, environment and products). Each teaching item is judged on a 5-point scale: 1 = Deficient, 2 = Inadequate, 3= Basic, 4 = Strong, and 5 = Exemplary.

All RAs were trained to use this measure either by the lead researcher of the larger pan-Canadian study (Savage, Georgiou, et al. 2017) or the project coordinator. The tool and each of its areas and items were first explored and explicitly explained to the RAs. They then watched a YouTube video of an elementary school English Language Arts (ELA) lesson and had to

complete the scoring sheet independently. The process was repeated until at least 80% inter-rater agreement was achieved.

During the classroom observations, there were always two RAs observing each lesson. Each observer sat in a different space of the room and observed a 1-hour ELA lesson at a time agreed upon with each participating teacher. Some English teachers, however, did not consent to being observed. Consequently, 95% of the participating classes were observed. However, across the 3 conditions, a representative proportion of teachers agreed to being observed. Analyses of inter-rater reliability of all class observations showed 93% agreement on CS, 94% agreement on LE, 98% agreement on BR, and 95% agreement on the PW areas of ELLCO.

Table 2

English Measures for Grade 1 Students Over the 2014-2015 School Year

	September-October 2014 (pretest)	**December 2014 (midtest)**	**April-May 2015 (post-test)**	**September-October 2015 (delayed post-test)**
Phonological awareness				
CTOPP - Segment	✓		✓	✓
DIBELS	✓		✓	
Word reading skills				
WRAT	✓	✓	✓	✓
WJ - Pseudoword	✓	✓	✓	✓
Fry	✓		✓	
Spelling skills				
WJ - Spelling	✓		✓	✓
Classroom environment				
ELLCO	✓		✓	

Note. CTOPP - Segment = Comprehensive Test of Phonological Processing, Nonword Segmention subtest; DIBELS - PSF = DIBELS Phoneme Segmentation Fluency subtest; WRAT = Wide Range Achievement Test III, Reading subtest; WJ - Pseudo = Woodcock-Johnson III Test of Achievement, Pseudoword reading subtest; FRY = 20 words from Fry high frequency word list; WJ - Spell = Woodcock-Johnson III Test of Achievement, Spelling subtest; ELLCO = Early Language and Literacy Classroom Observation

Table 3

English Measures for Grade 2 Students Over the 2014-2015 School Year

	September-October 2014 (pretest)	**December 2014 (midtest)**	**April-May 2015 (post-test)**	**September-October 2015 (delayed post-test)**
Phonological awareness				
CTOPP - Blend	✓	✓	✓	
Word reading skills				
WRAT	✓	✓	✓	✓
WJ - Pseudoword	✓	✓	✓	✓
DIBELS - Fluency	✓	✓	✓	✓
Spelling skills				
WJ - Spelling	✓		✓	✓
Classroom environment				
ELLCO	✓		✓	

Note. CTOPP Blend = Comprehensive, Test of Phonological Processing, Blending Words subtest; WRAT = Wide Range Achievement Test III, Reading subtest; WJ - Spell = Woodcock-Johnson III Test of Achievement, Spelling subtest; DIBELS – RF = DIBELS Reading Fluency subtest; WJ - Pseudo = Woodcock-Johnson III Test of Achievement, Pseudoword reading subtest; ELLCO = Early Language and Literacy Classroom Observation

The interventions that have been implemented in each grade are described in the following section.

First, in Kindergarten, four after-school English workshops of about an hour each were offered to parents of participating students. Those workshops aimed to teach them how to effectively support the development of their children's literacy skills at home with the help of shared-book reading and technology. In that matter, websites concerning best practices were used during the workshops and were available for all parents to consult afterwards.

Grade 1 and 2 professional development sessions. Professional development half-day workshops were conducted at the beginning of the fall semester with all participating teachers in Grade 1 and 2. The same workshops were given to all teachers in participating schools that were not in the control condition. In first grade, professional development for teachers in the experimental conditions concerned the best teaching practices regarding phonics. In Grade 2, teachers of the experimental conditions either received information concerning the "simplicity principle" or concerning best practices regarding vocabulary. In both grades, teachers in the "control" condition received a parallel set of sessions about socio-emotional development. The same approach was adopted for all professional development sessions regardless of the experimental condition or the grade level. The main investigator of the study met twice with the teachers between October and December and when needed, provided individualized support to the teachers.

Both in first and second grade, mid-testing of the entire sample was conducted in December. Students who performed below the 30% on the WRAT English word reading measure at midtest were judged "at-risk" and assigned to the supplemental intervention

associated to their school in January. Students were thus assigned to one of three experimental conditions.

Supplemental Interventions in Grade 1

The first two experimental supplemental interventions that are presented were researcher designed and consisted of three 30-minute out-of-class sessions per week delivered in the winter semester until a maximum of 12 hours was reached. The sessions usually took place in a quiet room of the school, on a schedule agreed on with teachers of the participating classrooms. The lessons were run with groups of 3-4 children from the same class if possible. If not, children from more than one classroom were combined to form a group. Even if students were all considered weak readers, the groups were composed of children of varying levels of reading ability. Indeed, some students knew almost all the letter-sounds in English whereas others knew only a couple. Some students were able to blend 4 or 5 phonemes together whereas others could only blend two. The interventions were run by research assistants (RAs), previously trained by either the researcher or the project coordinator. The training was undertaken in a two-hour meeting and role-play was used to make sure every RA was ready to carry out the intervention in schools. One week after the beginning of the intervention, the project coordinator met with the RAs to discuss the lessons of the week and to answer any further questions the RAs would have. The project coordinator and the researcher were also always available afterwards to answer any questions the RA might have. During the treatment integrity process, observers could also give direct feedback about the lesson to the RA, if required.

The Direct Mapping and Set-for-Variability Intervention (DMSfV) Program. This Grade 1 intervention was designed to incorporate every aspect of an effective and intensive systematic synthetic phonics programs as well as the teaching of word reading strategies.

Sessions were based on the following structure. Each session started with a review (2-5 minutes) and the teaching of a new GPC/reading strategy (5 minutes). Those were followed by a practice activity/game (10 minutes), as well as shared-book reading (10 minutes). The books used during shared reading were carefully selected to include a high density of the GPC taught during each lesson such that a GPC taught on a specific day was densely represented in shared texts given on that same day. The main goals of this program were to teach students letter-sounds, common digraphs and the principles of blending phonemes together, first with phonemes, and then from graphemes to phonemes. Common letter-sounds rules related to decoding in English were also taught to students (e.g. silent e-rule). Taught GPCs were chosen on the basis of frequency and consistency, in line with the work on the "simplicity principle" (Solity & Vousden, 2009; Vousden, Ellefson, Solity & Chater, 2011). Lessons were designed to allow for heavy differentiation, that is to say, the task was adapted to each student's ability level. For example, most struggling readers were given simpler words to decode (e.g. shorter words or words with only simple graphemes) whereas more advanced students were asked to decode more complicated words (e.g. longer words or words with multiple complex graphemes). The RAs' role in the differentiation was to ask each student to read words representing an acceptable challenge for them; words that were not too easy, but that were not impossible to read for them either. Lessons were also organized as to include games in order to support students' motivation. For example, rolling dices to get letters to blend together or using a snakes and ladders board games with words on each square. Lastly, one specific component of this intervention was the teaching of word reading strategies in relation to the concept of "set-for-variability" to help children decode words. Therefore, when students encountered unknown words they were unable to read, they were taught to try to match the decoded GPC chain to a word that sounded similar

in their lexicon. They were also taught to identify graphemes that could be sounded out as more than one phoneme and to then try to sound out the word with the other possible sounds of that grapheme. This allowed them to check which of the pronunciation created a word that made sense for them. They were also supported through purely oral language tasks to understand what an RA-given regularized pronunciation of spoken regular and exception words might be. For example, in a session on naming body parts the pronunciation of 'ou' in 'shoulder' was regularized by an RA, and children were asked to try to work out what the word might really be, and told that this is a strategy for reading words when they do not make sense.

Common or Best Practices (CBP) for Word Study Program. This intervention also aimed to teach phonics with effective teaching practices. It also included the teaching of frequent sight words. As the DMSfV, lessons' structure was always the same: review (2 minutes), letter-sound naming/grapheme phoneme correspondence teaching (3 minutes), phonics games (7 minutes), "sight word" reading (7 minutes) and shared-book reading (10 minutes). To work on phonics, games such as rolling dices with letters and combining them (blending sounds) to form a word were used. The goal of the phonics activities was to help students to develop their phoneme blending skills and learn GPCs. The latter were not chosen to respect a predetermined order, but were taught in response to children's knowledge. Thus, RAs would differentiate teaching so that students would first learn all singletons and then progress to digraphs and English reading rules (i.e. magic "e" rule). Overall, approximately the same number of digraphs was taught in the CBP and the DMSfV. Games in which children had to segment phonemes and write words were also introduced later in the intervention. Words used during the "sight words" phase of the lesson were drawn from a list of the 100 most frequent words in children's books (Vousden, Ellefson, Solity, & Chater, 2011, see Appendix C). Games such as snakes and ladders

(reading a word before moving pawn) were also used to sustain students' interest during this phase of the intervention. As in DMSfV, differentiation was used to adapt all tasks to students' ability level. Most struggling students would get easier words (i.e. length, GPC complexity, syllable structure) and stronger students, more complex words. However, compared to the DMSfV, books that were used in shared-book reading were not chosen depending on any specific GPC, but were rather chosen in line with students' interest (presenting two books and asking the students to choose). The RA would often present two preselected books that were convenient for students' age level and ask which one they would rather read. The RAs would ask kids to read only the words they considered they could read, following students' performance during the sessions. The number of words in books read by students thus increased during the interventions in relation with students' improving reading skills. For example, as the number of sight words recognized by students increased, the RAs would ask them to read it during shared-book reading. All words that were considered too complex (e.g. contained unknown GPCs) were read by the RAs. Lastly, no systematic teaching of word reading strategies such as set-for-variability was delivered in this program.

Classroom-based Support with Curricular and Socio-Emotional Foci (CSF) or Control condition. In this third condition, the plan was to expose participants to effective interventions to promote socio-emotional development. However, a certain number of schools refused permission for such work to be undertaken during curricular time. Therefore, to answer teachers' request, in-class support from an RA during ELA activities represented most of this condition's intervention. The socio-emotional aspect of the intervention represented only a small proportion of the sessions with the students. In contrast with the other conditions, this intervention was usually delivered within the classroom. Also, compared to the other

intervention, lessons were not systematically planned and delivered following a predetermined structure. Typically, the RA spent 90 minutes a week in the classroom either assisting the teacher during ELA activities or providing a socio-emotional intervention program. As mentioned before, often, teachers chose to use the RA to support small groups of at-risk students during academic tasks. Those activities ranged from word reading to reading comprehension or writing exercises. Sometimes, however, socio-emotional activities were also run with the whole class. Those lessons aimed to help children identify and label emotions, either their own of their friends' ones. The RA also taught kids ways to deal with their emotions and to resolve conflicts. Thus, this small proportion of the intervention targeted the development of better socio-emotional skills among students. While RAs mostly gave support to students during ELA activities, no systematic intervention on a specific aspect of reading or writing was given.

Supplemental Interventions in Grade 2

Preventative Intervention based on the "Simplicity Principle" (PIbSP). The intervention focused on the explicit teaching of the most frequent grapheme-phoneme correspondences that were not mastered by students, based on Vousden et al. (2011)'s ranked list of grapheme-phoneme mappings. Each lesson aimed to teach the spelling of a specific GPC (e.g. "or", "ou", "igh"). Each lesson followed a systematic and specific structure. First, the previous lesson was reviewed (5 minutes). Then the RA orally introduced a new word, without showing its written form containing the GPC that was the focus of the new lesson, and defined it with the students (2 minutes). Students then tried spelling the word on the board (2 minutes). The RA then revealed the right way to spell the word and asked the student to copy it in their notebook (2 minutes) and afterwards to write it down with magnetic letters (2 minutes). After that, during a shared-book reading activity (5-8 minutes), students had to try to find the word they had just

learned. Lastly, the RA introduced the special spelling unit in the words students learned, explained the "letter-sound rule" if necessary (2 minutes) and then asked to students to find other words containing this GPC (10 minutes). Pages of the book read that day were used to help children find words containing the target GPC. Books were thus chosen to include a high density of the target GPC of the day. Each lesson ended with a wrap up of what was learnt that day (2 minutes). GPCs were introduced strictly in the order provided by Vousden et al. (2011)'s ranked list of grapheme-phoneme mappings from most to least frequent. When the target GPC of the day was known by all students, RAs were authorized to skip the lesson to move forward to the next one. An example of a typical lesson can be found in Appendix I.

Preventative Intervention Oriented Towards Vocabulary (PIOTV). This intervention was similar to the Simplicity one, but focused on defining the same words used in the Simplicity intervention rather than on the spelling the words. Each lesson followed a systematic and specific structure. First, a review of the previous lesson (5 minutes) was done. Then, the RA introduced a new word and asked the students to try and find the various meaning of that word. If students could not find it, the RA could give them a sentence and ask them to find the meaning of the word in that context (5 minutes). Thus, compared to the PIbSP, more attention was given to defining the target word. Then, as in the PIbSP, the students had to try and spell out the word, the RA wrote the word on the board and they copied it in their notebook (5 minutes). Shared-book reading (5-8 minutes) was also done in the same way, asking children to find the target word of the day. The special spelling unit of the word was then introduced (2 minutes), but not explained by the RA. Therefore, students who took part in this intervention learned about word meanings but did not learn anything specific about the GPC apart from how it was spelled. Lastly, children

were asked to find other words with the same GPC in the book. An example of a typical lesson can be found in Appendix J.

Classroom-based Support with Curricular and Socio-Emotional Foci (CSF) or Control condition. The control condition in Grade 2 was designed the same way as in Grade 1. The lessons around socio-emotional development were different than those given in Grade 1, but still focused on emotion regulation and social skills. As in Grade 1, however, most of the time the RA ended up giving general academic support during ELA activities.

The number of participants in each condition in Grade 1 and in Grade 2 is displayed in Table 4.

Cross-linguistic transfer in French. All the interventions described above were conducted solely in English. In order to establish a causal relationship between the development of L1 and L2 skills, the reading performance in English and in French of participants in the experimental groups need to be compared to that of participants in the control group. Indeed, if significant additional improvements are observed in both English and French outcomes in one of the experimental groups, despite the fact the intervention occurred only in one language (i.e. English), it would suggest that the improvement in French is the result of cross-linguistic transfer. Thus, students performance in French on word reading (irregular words, regular words and nonwords) and spelling (nonwords) was assessed at the same time than the English measures, as described in

Table 2 and Table 3 above.

Table 4

Number of Participants in Each Condition

	Winter (For bottom 30% students)
Grade 1 (*N* = 99)	The Direct Mapping and Set-for-Variability Intervention (DMSfV) Program (*n* =52)
	Common Best Practices Program (*n* = 32)
	Classroom-based Support with Curricular and Socio-Emotional Foci (*n* = 15)
Grade 2 (*N* = 52)	Preventative Intervention based on the "Simplicity Principle" (PIbSP) (*n* =17)
	Preventative Intervention Oriented Towards Vocabulary (PIOTV) (*n* =17)
	Classroom-based Support with Curricular and Socio-Emotional Foci (*n* =18)

Measures

In order to assess students' ability to read and spell in French, measures of phonological awareness, word reading and spelling were used. The quality of classroom teaching in Grade 1 and Grade 2 was also assessed to gather information about the teaching of French in the different schools. Because participating students were already tested in English three times during the

school year, measurements in French was kept to a minimum to avoid disturbing regular teaching and overwhelming the students. The French measures were administered solely to Quebec participants for the purpose of the present study and were not part of the larger pan-Canadian study conducted by Savage, Georgiou, et al. (2017).

Standardized tests in French are still few in number (Cormier, Desrochers, & Sénécal, 2006) and even less so for Canadian/Quebec French. Indeed, most available tests (e.g. ODEDYS, BELEC) were developed and normalized with French European students. Thus, in the present research, the choice was made to use measures that were designed to evaluate Quebec students' French reading.

Therefore, part of the tests that were used measure French were taken from the standardized test battery "Épreuves de Compétence en Lecture (ECOLE)" developed by Professor Alain Desrochers from the University of Ottawa. The aim of Professor Desrochers was to develop measures with items that could help discriminate students experiencing reading difficulty by using percentile ranks. Those measures will be published through Pearson Assessment Canada over the next year. In the present research, the measures of phoneme blending, irregular and regular word reading of the "ECOLE" battery were used and are described in detail below. The measures were developed on the same theoretical and conceptual basis than the Woodcock Johnson III Test of Achievement (Woodcock et al. 2001), which is known as a valid and reliable measure. It should be noted, however, that the tests from the "ECOLE" battery were designed to contain 10 to 20 more items than the Woodcock Johnson's tests in order for the items' difficulty level to progress more smoothly. All tests were developed based on item response theory to produce an estimate of each item's: difficulty level, discrimination coefficient and student error margin. The measures have been used in a study

conducted by Professor Line Laplante in 2015. Results of that research will be submitted for publication over the next year. Unfortunately, at the time of publication of this thesis, the norms of the "ECOLE" measures were not yet available. Raw scores were thus used in the statistical analyses.

Standardized measure of phonemic awareness. A measure of phonological awareness was used to assess 1st grade students' ability to manipulate phonemes in French. The measure was validated among 323 Grade 1 students attending French schools in the greater Montreal area. The test assesses students' ability to blend a certain number of phonemes (between 2 and 7) in order to produce a word (e.g. /s/-/k/-/i/ makes "ski"). It contains 3 training items, 20 regular test items ($\alpha = .88$) and takes approximately 5 minutes to complete. The 20 items systematically progress on the basis of word length and syllabic structure complexity. For each item, the examiner pronounced a sequence of separate phonemes and then asked the student to identify the word that was composed of those phonemes. Following user's manual, the test was discontinued if the student obtained a score of 0 on four of six consecutive items. The test was administered to Grade 1 Quebec students only, three times in the school year: in September, December and June. The Spearman-Brown split half internal reliability in this sample was $r = .92$.

Standardized measure of word reading. Standardized measures of word reading were also used to assess 1st and 2nd grade students' word reading skills in French. A test of regular word reading, as well as a test of irregular word reading were used.

The list of regular words for Grade 1 contains only words built with simple graphemes (single letter grapheme) whereas the list for Grade 2 also encloses words with complex graphemes (multiple letter grapheme). Both measures were validated among French elementary

school students in the greater Montreal area (Grade 1: n = 322; Grade 2, n = 238). Both lists include only words that follow orthographic patterns that are regular in French. In Grade 1, items were selected to progress in terms of word length and frequency whereas in Grade 2, items were selected only based on their frequency. Each list contains 36 items and was found to be highly reliable (Grade 1: α = .93; Grade 2: α = .96). Lamarche and Desrochers (2016) examined the concurrent validity of both lists with the regular word reading tests from the "Batterie d'Évaluation du Langage Écrit (BELEC)" (Mousty, Leybaert, Alegria, Content, & Morais, 1994), a widely used standardized test in French language. Correlations between performance on the regular word reading test of the "ECOLE" and "BELEC" batteries were high (r = .83), indicating that they measure very similar constructs. The Spearman-Brown split half internal reliability was r = .97 in this Grade 1 sample and r = .90 for this Grade 2 sample.

As opposed to regular words, a single irregular word list was used both in Grade 1 and Grade 2. The list contains 36 items (α = .94) selected based on word length and frequency. All items were also selected to contain at least one inconsistent GPC in French. The choice of items was also led by the conceptual basis underlying the word reading lists developed by Sprenger-Charolles, Colé, Béchennec, & Kipffer-Piquard (2005). The measure was validated among 238 Grade 1 and 2 students attending French elementary schools in the greater Montreal region. In an evaluation of concurrent validity, Lamarche and Desrochers (2016) demonstrated that the correlation between performance on the irregular word reading tests of the "ECOLE" and "BELEC" (Mousty et al., 1994) batteries was high (r = .81), indicating that they measure very similar constructs. The Spearman-Brown split half internal reliability in this sample was r = .95.

The irregular and regular word lists are independent measures and words on each list were not matched with those on the other list. For both the regular and the irregular word lists,

the test administration procedure was the same. In accordance with the instructions of the test, the examiner presented a page with a group of four words and asked the student to read all words from the top of the page to the bottom. This procedure continued through all 36 items and was discontinued if the student provided 4 incorrect answers within 6 consecutive words.

Both regular and irregular word tests were administered three times in the school year: in September, December and June.

Both standardized and experimental measures that were not part of the "ECOLE" battery were also used to measure students' reading and spelling skills in French. They are described more precisely below.

Experimental measures of word reading. Because standardized tests are not designed to measure transfer of learning, two experimental lists of nonwords were also used to assess participants' ability to decode specific GPCs: one for Grade 1 (see Appendix E) students and the other for Grade 2 students (see Appendix F). Both lists were developed by the author of the present thesis. In Grade 1, 12 nonwords were built with simple graphemes whereas the other 18 also contained nonwords with complex graphemes. In Grade 2, the list was designed to contain 30 nonwords, 10 in each of the following categories; words with taught GPCs shared with English (e.g., hard and soft "c" and "g"), words with GPCs that are unique to French (e.g., "eu" or "eau") and words containing GPCs that are used in both languages but that do not map to the same phonemes (e.g. "ou" or in). For example, the grapheme "an" corresponds to one phoneme (i.e., /ɑ̃/) in French but is generally associated with two phonemes in English (i.e., /ɑ n/). Those graphemes could be confused by students and could be a good indicator of transfer. Words syllabic structure was also taken into account when building the list. The 10 words in each

category were all matched on syllabic structure. The 10 nonwords of each category were also matched relative to target grapheme frequency. Therefore, the target graphemes in the words each category were all similarly frequent. In total, target graphemes in the three categories all had an overall average sublexical frequency of 13000 as measured with MANULEX database (Lété, Sprenger-Charolles, & Colé, 2007). The list for 1st grade students contained words with a simpler structure and basic GPCs (e.g., en, ou, on, au) whereas the list for 2nd grade students included words with a more complex structure and with more advanced GPCs (e.g., eau, soft and hard c). The test lasted approximately 10 to 15 minutes and was administered three times in the school year; in September, December and June. The test was designed to enable the testing the hypothesis derived from Kuo and Anderson's (2010) theory which suggested that transfer would be greater for GPCs that are shared between languages than for the ones that are unique and that transfer would also be greater at the process level than at the specific knowledge level. The Spearman-Brown split half internal reliability in this sample was $r = .93$ for the Grade 1 list and $r = .92$ for the Grade 2 list.

Experimental measure of spelling. As for nonword reading, an experimental nonword list (see Appendix H) was used to assess Grade 2 participants' ability to spell specific phoneme-grapheme correspondences. Nonwords rather than real words were preferred since children had to rely only on their GPC knowledge and could not access the word in their mental lexicon. Building nonwords rather than using a standardized test also allowed to control the GPCs that constitute each word, which was important to be able to evaluate transfer. Indeed, standardized spelling tests are not designed to enable cross-linguistic transfer. The spelling test contained 15 items and was administered three times during the school year for 2nd grade students: in September, December and June. Items were composed of GPCs that were the subject of

instruction in reading. The Spearman-Brown split half internal reliability in this sample was $r = .83$.

Fluency. As in other reading areas, no standardized test of fluency was available in French for bilingual students. Therefore, under the recommendation of Professor Alain Desrochers, the measure "*Le Texte de Marie"* (Burion, 1961) was used to evaluate students' oral reading fluency in French in Grade 2. This measure was used in other studies to measure elementary or high school students' word reading speed (e.g. Boutin, 2012). Students were asked to read the text to the best of their knowledge for a maximum of 2 minutes. According to the testing manual, the examiner took note of words that were not read accurately and read the word for the student if he/she was unable to read the word for 5 seconds. Oral reading speed could afterward be computed by calculating the number of underlined words on the answer sheet that had been adequately identified by the student. Overall, 150 out of the 334 words are underlined. The words of the text become more and more difficult as the student progress through it.

All word reading and spelling tasks were administered by a research assistant in one-on-one sessions with each participant. The testing generally took place in a silent room available that day in the school. All tests were generally completed within a 20 to 30 minute session, except when students expressed the need to rest. For any of those measures, the testing stopped if the participant exceeded the approximated time required to complete the test or if the participant was unable to complete the first 10 items of the test.

Classroom environment. The *Early Language and Literacy Classroom Observation* (ELLCO) (Smith et al., 2008) was also used to assess the quality of the classroom environment and teachers' literacy practices in French in both 1st and 2nd grade. As for the English lessons,

two observations were done in the school year (i.e., September and May) in order to gather complete information about the classroom environment during French lessons. Information about contextual factors can support the interpretation of the data concerning the literacy skills of students. As mentioned by Koda (2012a), "integrating psycholinguistics and contextual factors in a coherent framework is challenging, but it is vital, if we are to gain a more comprehensive grasp of L2 reading development (p. 316).

All observations were made by the main investigator and a research assistant. The RA received the same training as the RAs observing English lessons (for a detailed description see p. 80). Both observers were present for all observations, sat in different areas of the classroom and completed independent ratings at the end of each observation. All participating teachers agreed to being observed. Analyses of inter-rater reliability of all class observations showed a within-one-point perfect agreement of 97% on CS, 99% on LE, 99% on CU, 98% on BR and 96% on the PW aspects of ELLCO. An analysis of Cohen's κ was also run to evaluate the degree of agreement between observers and indicate there was a moderate agreement between both observers $\kappa = .566$, $p < .000$.

Table 5 and Table 6 summarize the data collection over the 2014-2015 school year for each grade.

Table 5

French Measures for Grade 1 Students Over the 2014-2015 School Year

	September-October 2014 (pretest)	**December 2014 (midtest)**	**April-May 2015 (post-test)**
Phonological awareness			
Phoneme blending task	✓	✓	✓
Word reading skills			
Irregular	✓	✓	✓
Regular	✓	✓	✓
Nonwords	✓	✓	✓
GPC	✓	✓	✓
Classroom environment			
ELLCO	✓		✓

Note. Phonological awareness = Phoneme Blending task, Irregular = Irregular word list, Regular = Regular word list (simple and complex graphemes), Nonwords = experimental nonwords list (Grade 2), GPC = Grapheme to phoneme conversion task, ELLCO = Early Language and Literacy Classroom Observation

Table 6

French Measures for Grade 2 Students Over the 2014-2015 School Year

	September-October 2014 (pretest)	**December 2014 (midtest)**	**April-May 2015 (post-test)**
Word reading skills			
Irregular words	✓	✓	✓
Regular words	✓	✓	✓
Nonwords	✓	✓	✓
Fluency			
Texte de Marie	✓	✓	✓
Spelling			
Pseudoword spelling	✓	✓	✓
Classroom environment			
ELLCO	✓		✓

Note. Irregular = Irregular word list, Regular = Regular word list (simple and complex graphemes), Nonwords = experimental nonwords list (Grade 2), GPC = Grapheme to phoneme conversion task, Spelling = experimental nonwords list, Fluency = Test de Marie (reading fluency rate), ELLCO = Early Language and Literacy Classroom Observation

Part IV: Results

Overview

The main objective of this experimental research was to investigate the cross-linguistic impacts of effective reading instruction in English on reading and spelling performance in French among 1st and 2nd grade students attending French Immersion programs in Quebec. The secondary objective was to identify what is actually transferred between languages: Specific knowledge (i.e., transfer of specific GPC) or more general principles (i.e., letter-sound rules generalization). Two specific research questions were addressed in this study: 1) What are the impacts of preventative and supplemental interventions in English on the cross-linguistic transfer of decoding and spelling skills in French among Grade 1 and Grade 2 at-risk students respectively? 2) Does transfer occur at the level of specific knowledge (e.g. specific GPC) or at the more general level of process (e.g. letter-sound rules generalization)?

In order to determine the impact of the interventions, experimental and control groups' results were compared regarding decoding and spelling outcomes. To do so, hierarchical lineal modeling (HLM) was used to examine cross-linguistic transfer between English and French, as well as to identify what type of knowledge was transferred between those two languages. The next section presents a review of preliminary data analyses and then reports the findings for each of the research questions.

Preliminary Data Analysis

Data screening. Prior to analysis, the accuracy of the raw data was examined by checking 20% of data point entries in the SPSS database. During this inspection, only 46 data

point errors were found out of 22461 data cells. This represents 0.2% of the examined sample which was considered to be an acceptable degree of random error.

Missing data. For two of the participants in the sample, data from two out of the three data collection phases was missing. Those cases were not included in further analyses. Using IBM SPSS' Missing Value Analysis (MVA) tool, it was found that only 1.69% of the total data were missing, which is considered acceptable if it is missing at random. The missing values generally represented student's absence at one of the data collection phases or participation in the study at a later point in time, which made pretest data collection impossible.

Thus, the pattern of missing data was examined before making any inferential analyses. First, the missing data for the whole database, including at-risk and not at-risk students, was explored. The MVA tool tests and evaluates if the pattern of missing data is random or not. To do so, Little's MCAR test is used to check whether the subjects with missing values are significantly different than the subjects without missing values. If the test result is statistically nonsignificant (i.e. $p \geq .05$), values can be considered missing at random. For the G1 dataset, there was less than 5% (1.94%) of missing data and it was considered to be missing completely at random according to Little's MCAR test; $\chi 2\ (61) = 49.07$, $p = .864$. Similarly, in the G2 database, there was less than 5% (1.43%) of missing data for all variables. Little's MCAR test was thus conducted and revealed that data were missing completely at random: $\chi 2\ (105) = 105.87$, $p = .458$.

To make sure that the pattern of missing data was also random in the at-risk sample, the same procedure was applied. In the Grade 1 database of at-risk students, no more than 2% of data were missing for each variable. The missing values generally represented student's absence

at one of the data collection phases (e.g. absence due to travel in their native country). In the Grade 2 database, no data were missing.

Outliers. Screening for candidate outliers was also completed. All data points at least two standard deviations above each variable mean were considered as possible outliers. Only one score in the whole dataset met that criterion. No significant differences were found in the results when running the analyses with or without the potential outliers. Results reported below thus include the full sample.

Distributions. As for any parametric analysis, certain assumptions need to be met for HLM analyses to be appropriate. Thus, using the SPSS software 19, descriptive statistics were inspected in order to confirm that assumptions of normality, linearity and homogeneity of variance were met using standard approaches (Tabachnick & Fidell, 2007). Residuals were saved for each HLM model and were then visually inspected using Q-Q plots and scatter plots. Standard assumptions of linearity, normality and heteroscedacity were met in all cases but one. Indeed, the examination of Q-Q plots for French regular word reading at post-test revealed a deviation from normality, as well as heteroscedacity. A log10 transformation was thus performed on that variable, which has produced normally distributed residuals as well as homogeneous variance. HLM analyses were conducted using transformed and untransformed variables and results differed substantively. Therefore, the decision was made to report the results of the analyses obtained using the log10 transformed regular word reading variable at post-test and untransformed data for all other variables.

In multilevel analyses, collinearity between the predictor variables can also lead to statistical problems in the parameters estimation. The presence of collinearity might bias the

estimation of the various parameters as well as inflate the associated standard errors (Yu, Jiang, & Land, 2015). To check for the presence of collinearity, the variance inflation factor (VIF) as well as the tolerance scores were considered for all level 1 and 2 variables. For all variables, VIF were below 2.00 and the tolerance scores near 1.00, which indicated that no problems of collinearity are present in the data.

Descriptive statistics for every French reading and spelling outcome in Grade 1 and Grade 2 are presented in Table 7 to Table 8. In order to facilitate comparison between languages and to explore cross-linguistic transfer, the same are presented for English outcomes for the Quebec-only sample in Table 9 to Table 10. Results of the French phonological awareness and word reading measures in French in Grade 1 displayed in Table 7 suggest there was a greater change between midtest and post-test mean scores for students in the DMSfV condition. This change in favor of the DMSfV condition, when compared to the other conditions, is particularly important for the outcomes of irregular and regular word reading. With respect to Grade 2 results (see Table 8), change between midtest and post-test results are often very similar for all conditions, and is sometimes slightly greater for the control condition. All presented data in Table 7 and Table 8 are raw scores. Indeed, as explained in the method section, at the time of publication of this thesis, the norms of the standardized measures in French were not yet available. It was then only possible to use the raw scores to conduct the analyses.

Table 7

Means and Standard Deviations for French Midtest and Post-test Measures in Grade 1

		DMSfV				CBP				CSF			
Measure	Max[a]	Midtest		Post-test		Midtest		Post-test		Midtest		Post-test	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
PA	20	9.04	(5.39)	14.15	(5.37)	7.75	(5.19)	11.16	(5.70)	3.80	(3.19)	10.43	(5.46)
Irregular	36	0.48	(0.70)	4.26	(4.23)	0.16	(0.51)	0.94	(1.41)	0.60	(1.12)	1.29	(1.59)
Regular	36	0.70	(4.19)	10.89	(9.37)	2.19	(2.78)	5.77	(6.33)	2.00	(1.73)	5.14	(3.86)
Nonword	30	4.42	(4.26)	12.94	(7.91)	2.91	(3.53)	7.68	(6.43)	1.67	(2.16)	9.07	(6.71)
GPC	12	4.19	(2.25)	6.42	(4.63)	1.34	(2.28)	3.77	(3.80)	1.33	(1.18)	4.64	(3.63)

Note. PA = Phonological awareness – Blending task; Irregular = Irregular word list; Regular = Regular word list (simple graphemes only); Nonword = experimental nonword list (Grade 1); GPC = Grapheme to phoneme conversion task.

All presented values are raw scores.

[a] Maximum score for each test

Table 8

Means and Standard Deviations for French Midtest and Post-test Measures in Grade 2

		Simplicity				Vocabulary				CSF			
Measure	Max[a]	Midtest		Post-test		Midtest		Post-test		Midtest		Post-test	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Irregular	36	2.19	(2.95)	4.25	(5.04)	3.50	(4.40)	4.81	(5.38)	1.12	(2.03)	2.24	(2.04)
Regular	36	4.56	(5.93)	8.19	(10.31)	6.75	(7.80)	10.13	(10.46)	1.64	(1.80)	5.06	(5.23)
Nonword	30	7.31	(6.75)	10.88	(7.82)	10.06	(9.26)	14.19	(8.69)	4.12	(4.39)	9.41	(4.89)
GPC	12	4.63	(3.81)	5.06	(4.36)	6.19	(4.79)	7.94	(4.71)	2.82	(1.88)	4.65	(3.00)
Spelling	12	8.63	(6.41)	9.75	(6.26)	10.44	(6.72)	11.56	(5.39)	7.64	(3.81)	8.71	(4.01)
Fluency	150	19.19	(12.58)	27.25	(18.11)	19.25	(15.40)	27.00	(16.94)	16.18	(7.33)	24.06	(11.72)

Note. Irregular = Irregular word list; Regular = Regular word list (simple and complex graphemes); Nonwords = experimental nonwords list (Grade 2); GPC = Grapheme to phoneme conversion task; Spelling = experimental nonwords list; Fluency = Test de Marie (reading fluency rate).

All values presented are raw scores.

[a] Maximum score for each test

Table 9

Means and Standard Deviations for English Midtest and Post-test Measures in Grade 1

		DMSfV				CBP				CSF			
Measure	Max[a]	Midtest		Post-test		Midtest		Post-test		Midtest		Post-test	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
WRAT	70	16.51	(2.67)	24.60	(6.28)	15.69	(3.16)	20.78	(4.84)	16.29	(3.07)	19.57	(5.40)
FRY	20	-	-	12.46	(5.68)	-	-	10.61	(5.54)	-	-	11.29	(6.73)
CTOPP - SEG.	31	-	-	9.18	(4.60)	-	-	7.28	(3.99)	-	-	8.71	(4.03)
WJ - SPELL	59	-	-	19.53	(3.25)	-	-	17.78	(3.78)	-	-	18.21	(4.44)
WJ - PSEUDO	32	4.69	(2.22)	8.44	(4.89)	4.41	(1.76)	6.72	(3.63)	3.43	(1.34)	5.93	(2.89)
DIBELS-PSF	70	-	-	42.95	(17.75)	-	-	33.72	(18.64)	-	-	39.57	(20.64)

Note. WRAT = Wide Range Achievement Test III, Reading subtest; FRY = 20 words from Fry high frequency word list; CTOPP – SEG. = Comprehensive Test of Phonological Processing, Nonword segmentation subtest; WJ - Spell = Woodcock-Johnson III Test of Achievement, Spelling subtest; WJ - Pseudo = Woodcock-Johnson III Test of Achievement, Pseudoword reading subtest; DIBELS - PSF = DIBELS, Phoneme Segmentation Fluency subtest.

All values presented are raw scores.

[a] Maximum score for each test

Table 10

Means and Standard Deviations for English Midtest and Post-test Measures in Grade 2

		Simplicity				Vocabulary				CSF			
Measure	Max[a]	Midtest		Post-test		Midtest		Post-test		Midtest		Post-test	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
WRAT	70	22.64	(4.80)	28.27	(7.18)	20.94	(4.70)	23.65	(5.83)	21.78	(3.08)	26.78	(6.72)
CTOPP - B.	33	21.06	6.40	25.44	(3.24)	21.59	(6.17)	22.12	(7.93)	20.56	(5.45)	22.94	(6.55)
WJ - SPELL	59	-	-	21.83	(3.67)	-	-	20.82	(4.30)	-	-	22.22	(2.90)
WJ - PSEUDO	32	7.18	(3.30)	11.78	(5.61)	6.76	(3.07)	8.94	(4.83)	8.17	(3.54)	9.67	(5.35)
DIBELS-RF	265	26.71	(21.68)	42.11	(24.15)	17.59	(14.36)	31.41	(21.05)	28.89	(15.01)	40.39	(23.00)

Note. WRAT = Wide Range Achievement Test III, Reading subtest; CTOPP B. = Comprehensive Test of Phonological Processing, Blending Words subtest; WJ - Spell = Woodcock-Johnson III Test of Achievement, Spelling subtest, WJ - Pseudo = Woodcock-Johnson III Test of Achievement, Pseudoword reading subtest; DIBELS – RF = DIBELS Reading Fluency subtest.

All values presented are raw scores.

[a] Maximum score for each test

Teaching practices. The present experiment was conducted in the context of a matched control study and schools, rather than classrooms, were randomly assigned to one of three experimental conditions. Therefore, prior to any analyses, it was essential to compare the learning environments in which biliterate students learned French for two reasons. First, as was done in English, it was necessary to evaluate teaching practices in L2 to ensure that all students were receiving quality instruction in L1 and in L2 and that consequently their difficulties did not arise from teaching practices that were not well-aligned with evidence-based practice. As mentioned before, quality of instruction was assessed with the ELLCO (see p.98 for detailed description). Instruction was considered of quality when teachers obtained an average score between 3 and 5 on the 18 items of the tool. On the contrary, an average score of 1 or 2 was considered as inadequate or low quality instruction. Second, it was also important to demonstrate the absence of significant differences between classrooms' teaching practices across intervention condition to confirm that such differences did not influence the outcome of the small-group intervention.

Thus, direct observation of teaching practices in French was completed twice in the school year (October and April) using the ELLCO observational tool. Simple ANOVA were conducted in order to determine if the three experimental conditions (i.e., DMSfV, CBP, CSF in Grade 1 and Simplicity, Vocabulary, CSF in Grade 2) differed regarding teaching practices. Results revealed that no significant differences ($p > .05$) existed between the experimental groups at Time 1 or Time 2, in Grade 1 and in Grade 2. In addition, an analysis of the scores of all teachers on the ELLCO revealed that the observers rated teaching practices as being "Basic", "Strong" or "Excellent" 96% of the time in Grade 1 and 93% of the time in Grade 2. Those results suggest that students were exposed to quality instruction in L2 and that in a general sense,

instructional practices could not have hindered students' literacy learning, and nor could systematic variation in teaching quality have been a confound in by-intervention condition contrasts of student attainment presented above in Table 7 to Table 10.

Rationale for Using HLM to Respond to Research Questions

Traditionally, in randomized controlled experimental design, student-level analyses are used to compare group means and determine if there is a significant difference between groups. However, in this study, the influence of classroom environment on student outcomes of reading and spelling in French needs to be considered. Students were nested within classrooms and it is thus assumed that children within a same class shared contextual influences of the classroom, which in turn influenced individual outcomes. Also, schools, rather than individuals, were assigned to one of the three experimental conditions, yielding observations and measures that cannot be considered to be independent. Conducting student-level analyses ignoring the nested nature of the data would inflate Type I error rate (Tabachnick & Fidell, 2007). Hierarchical linear modeling is thus the appropriate type of analysis to take into account the structural nature of the data since the assumption of independence of errors does not need to be met. Those models are specifically designed to model the relationships between cases nested in higher level clusters (Field, 2009) and for that reason, their use has been strongly recommended in the literature (Gersten, Fuchs, Compton, Coyne, Greenwood, & Innocenti, 2005).

Multilevel modeling is an extension of linear regression analyses in which each level (i.e. students and classroom) is represented by its own submodel that explains the relationship between the independent and the dependent variables. In these models, the intercept and slopes coefficients of random effects are allowed to vary between higher-level units (i.e. classrooms), allowing investigators to account for the difference between groups. Therefore, one of the

advantages of hierarchical linear modeling is to partition the variance and covariance of the data to produce within-group and between-group components. Variance is thus calculated between each level 2 unit (i.e. classrooms) and the grand mean, as well as for each individual within each level 2 unit and the mean of its group.

Hierarchical analyses are generally conducted in well-explicated steps wherein later 'final' models are built upon their proven suitability, established at earlier steps. First, an intercept-only ("null") model with no predictors is computed to determine if there is a significant difference between the groups on the outcome variable to warrant hierarchical modeling. In the following models, first- and then second level predictors are then added one by one to formally test their significant contribution to the model, and thus the need for their inclusion, in the model. By comparing the residual variance between models, it is also possible to estimate how much variance is accounted for by the newly added parameter.

Centering. In HLM, it is possible to perform a transformation of the predictor variable in order to ease their interpretation. It is most commonly done with level-1 variables (Tabachnick & Fidell, 2007). Two main types of centering are possible: Grand-mean centering and group mean centering. Centering scores around the grand mean (i.e. subtracting sample mean from each participant's score on a given variable) will modify the intercept (γ_{00}) of the model, but none of the other parameters. Thus, centering does not affect the relationship between variables, but helps to interpret the intercept since it then represents the mean score on the dependent variable at the average level of the independent variable. Group-mean centering (subtracting group mean from each case) is also possible and is usually done by centering a level 1 variable around means of a level 2 variable (Field, 2009). Even if it is a common practice in HLM, centering is possible

only with continuous predictor variables (i.e. categorical variables cannot be centered) and is not necessary when the variables have a meaningful true zero that is easily interpretable. In the case of the present study, continuous predictor variables are raw unstandardized measures, and were left uncentered since they all have easily interpretable zero point values.

Model specification. To seek an answer the research questions of the present study, a two-level model is hypothesized with predictors at both levels (experimental condition and midtest scores) where level 1 is student's scores and level 2 is the classroom mean score. Classrooms, rather than the intervention small-groups, were chosen as the level 2 units since students from the same classroom were more likely to be similar than students from different classrooms. Moreover, students in a given small-group were generally from the same classroom. No interactions are hypothesized, either within or between levels. First, an intercept-only ("null") model with no predictors was tested in order to determine if there was appreciable between-groups variance regarding individual outcomes in various reading measures (phonological awareness, irregular words, regular words, nonwords and GPC). This is a model equivalent to a One-Way ANOVA with random effects. If no appreciable variability is found between groups, single-level analyses would be considered a more adequate analysis.

Model 1: One-Way ANOVA with Random Effects (Unconditional means model)

Level-1 Model

$READING_{ij} = \beta_{0j} + r_{ij}$

Level-2 Model

$\beta_{0j} = \gamma_{00} + \mu_{0j}$

Mixed-model form (Level-1 and -2 equations)

$READING_{ij} = \gamma_{00} + \mu_{0j} + r_{ij}$

In this model, the level-1 equation represents how the reading outcome for students (*i*) in classroom (*j*) is predicted by the classroom mean score in reading which is called the intercept (β_{0j}), and the level-1 random error (r_{ij}). The level-2 equation shows that the intercept (β_{0j}) (i.e. class mean) is predicted by the grand mean of reading scores as well as the random effect (μ_{0j}) representing the variability of each classroom to the grand mean.

This unconditional model is first estimated to assess whether the level-2 units differ on the outcome variable but also to determine the degree of dependence in the outcome across level-1 units. The model takes account of variance both at level-1 (r_{ij}) and level-2 (μ_{0j}) of the hierarchy on the outcome variable. Having information about variability at both levels then allows the calculation of the ratio between variance between groups and the variance within those groups, which is referred to as the intraclass correlation coefficient (ICC). Therefore, the ICC is the proportion of total variance in the outcome that can be accounted for by level-2 units

(i.e. classrooms). If a considerable ICC is found, it indicates that there is dependency in the data and that HLM is the proper analysis to answer research questions (Hayes, 2006).

Then, a second model is developed, in which a level-1 predictor (i.e. midtest scores) is added to the first model in order to predict reading scores. Midtest scores were thus added to the model as level-1 predictors and considered as random effects, meaning they are allowed to vary between level-2 units (i.e. classrooms).

Model 2: Random-coefficient ANOVA Model (Model with a level-1and level 2 predictor)

Level-1 Model

$$READING_{ij} = \beta_{0j} + \beta_{1j}*(MIDTEST_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + \gamma_{10}(MIDTEST) + \mu_{0j}$$

$$\beta_{1j} = \gamma_{20} + \mu_{1j}$$

Mixed-model form (Level-1 and -2 equations)

$$READING_{ij} = \gamma_{00} + \mu_{0j} + \gamma_{10}*(MIDTEST_{ij}) + + \gamma_{20} + \mu_{1j} + r_{ij}$$

In this model, the level-1 equation is expanded and individual scores in reading are predicted by a random intercept (β_{0j}) (i.e. classroom means), the coefficient (β_{1j}) quantifying the relationship between midtest and post-test scores and random error (r_{ij}). The level-2 equations were expanded as well to control for midtest differences in classroom means. Thus, the intercept for the classroom reading scores (β_{0j}) is predicted by the average reading score (γ_{00}), plus the effect of midtest (i.e. classroom means) (γ_{10}) and the random effect of level-2 units (μ_{0j}) (i.e.

deviation of each classroom from the grand mean). The second level-2 equation represents the slope (β_{1j}) associated with the effect of midtest. Since it is considered as a random effect (i.e. allowed to vary across classrooms), a fixed component (γ_{20}), as well as a random component (μ_{1j}) are used in the equation to predict the effect of midtest.

Lastly, another model was tested in which a level-2 predictor (i.e. condition) is added and considered as a fixed effect in the model since it is not expected to vary across level-2 units (i.e. classrooms).

Model 3: One-way ANCOVA with Fixed and Random Effects

Level-1 Model

$$READING_{ij} = \beta_{0j} + \beta_{1j}*(MIDTEST_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + \gamma_{10}(MIDTEST) + \gamma_{20}(CONDITION) + \mu_{0j}$$

$$\beta_{1j} = \gamma_{30} + \mu_{1j}$$

Mixed-model form (Level-1 and -2 equations)

$$READING_{ij} = \gamma_{00} + \gamma_{10}(MIDTEST) + \mu_{0j} + \gamma_{20}*(CONDITION) + \gamma_{30} + \mu_{1j} + r_{ij}$$

In this last model, the level-1 equation remains unchanged. The level-2 equations, however, are expanded to include the impact of the experimental condition. The first level-2 equation, the intercept for reading scores (β_{0j}) is predicted by the average reading score (γ_{00}) plus the effect of midtest (γ_{10}), plus the effect of condition (γ_{20}), and the random effect of level-2 units (μ_{0j}) (i.e. deviation of each classroom from the grand mean). Since the experimental

condition is considered as a fixed effect (i.e. constant across classrooms), only a fixed component (γ_{30}) is used in the equation. The second equation represents how the effect of midtest is predicted by a fixed intercept adjusted by class (γ_{30}) and a random component representing variation between classes (μ_{1j}).

Those final models were run for each Grade 1 and Grade 2 reading outcomes in English and in French. However, for the French variables "spelling" and "fluency" in Grade 2, the final models did not converge but the pre-final ones, that is the Random-coefficient ANOVA models, did converge. Thus, for those two variables only, analyses were run without the random intercept and covariate in order for the matrices to converge. Results of those simplified models are reported for those two outcomes only. The same procedure was adopted when testing the model relative to one of the phonological awareness outcome (i.e. CTOPP- Segment) at delayed post-test.

The overall fit of every multilevel model was tested by examining values of the log-likelihood criterion. Those values are the results of a chi-square likelihood test and it is common practice in multilevel modeling to use those values to compare models (Field, 2009). A smaller log-likelihood value indicates a better-fitting model. Therefore, for each reading outcome, the -2 log-likelihood values associated with each model were compared to ensure the goodness of fit of the final model. In most comparisons, model 3 was the one with the smallest log-likelihood value and thus, was the one representing a better fit to the data. In some cases, where the covariate did not explain any variance, model 2 was a better option as it represented the data more appropriately. Cases where model 2 was preferred to model 3 are explicitly mentioned for each of the analyses below.

Specific study design characteristics are necessary in order to isolate the effect of an intervention and provide evidence of the existence of a causal link between the intervention and the research findings (What Works Clearinghouse, 2015). One of those characteristics is the random assignment of participants to the experimental or control groups. Indeed, randomly assigning participants helps, with a sufficiently large sample, to obtain groups that are comparable in terms of their various characteristics. Then, if the only difference between groups is the exposure to the intervention, any significant differences in the results can be attributed to the intervention. In the present study, schools rather than students, were randomly assigned in groups. Thus, in order to confirm that the three experimental groups were comparable and that they did not differ either in terms of children's characteristics and home environment, additional analyses (i.e. chi-square and simple ANOVA) were conducted. The overall matching of Grade 1 participants was reported in Savage, Georgiou, et al. (2017), but since the present study was conducted with Quebec only data, analyses were conducted to confirm those data sets were well matched too. Thus, using information collected through a questionnaire to parents in Kindergarten, various participants' specific characteristics (gender, mother's education, home language, or parent-reported first language, vocabulary level) were explored.

Descriptive statistics for those variables in Grade 1 are reported in Table 11. In order to prevent errors associated with performing multiple statistical tests, a Bonferroni correction was used to adjust the alpha level necessary to reject the null hypothesis. The alpha level was thus set to $p < 0.007$. Results of the chi-square analyses show that none of the variables were significantly different between groups. Indeed, analyses for gender (χ^2 (2, N = 105), = 0.938, p = 0.626), mother L1 (χ^2 (4, N = 95), = 9.51, p = 0.49), father L1 (χ^2 (6, N = 94), = 12.95, p = 0.012), language between mother and child (χ^2 (6, N = 95), = 11.29, p = 0.08), language

between father and child (χ^2 (8, N = 95), = 20.63, p = 0.008), mother's education level (χ^2 (6, N = 94), = 12.41, p = 0.015) and learning disability diagnosis (χ^2 (4, N = 97), = 3.94, p = 0.414) did not meet the p = 0.007 criteria. Even where significant under conventional alpha levels, the analyses favored the control group, which mitigates against the research hypotheses favoring the intervention condition.

The same procedure was carried out with the Grade 2 sample. Results are displayed in Table 12. Results of the chi-square analyses show that none of the variables were significantly different between groups. Indeed, analyses for gender (χ^2 (2, N = 53), = 0.490, p = 0.783), mother L1 (χ^2 (4, N = 48), = 7.71, p = 0.103), father L1 (χ^2 (4, N = 47), = 5.79, p = 0.216), language between mother and child (χ^2 (6, N = 48), = 5.00, p = 0.544), language between father and child (χ^2 (8, N = 48), = 6.893, p = 0.331), mother's education level (χ^2 (4, N = 48), = 11.99, p = 0.017) and learning disability diagnosis (χ^2 (2, N = 48), = 0.51, p = 0.975) did not meet the p = 0.007 criteria. Even where significant under conventional alpha levels, like mother's education level, the analyses favored the control group, which mitigates against the research hypotheses favoring the intervention condition.

Results of the ANOVA concerning the Peabody Picture Vocabulary Test (PPVT) in English are reported in Table 13. They show that no significant difference existed between groups concerning vocabulary in Grade 1 or in Grade 2. Consequently, it was concluded that none of the extraneous variables mentioned above affected either English or French reading outcomes in Grade 1 or Grade 2 and thus, did not need to be included in the final multilevel models.

Table 11

Descriptive Statistics for Participants' Characteristics in Grade 1

	DMSfV	CBP	CSF
	Mean	Mean	Mean
Gender			
Girl	61.4%	51.5%	53.3%
Boy	38.6%	48.5%	46.7%
Mother L1			
English	36.4%	46.4%	21.4%
French	20%	32.1%	0%
Other	43.6%	21.4%	66.7%
Father L1			
English	49.1%	39.4%	33.3%
French	8.8%	27.3%	0%
Other	38.6%	18.2%	46.7%
Language mother and child			
English	67.3%	46.4%	66.7%
French	10.9%	25%	0%
English and French	16.4%	10.7%	8.3%
Other	5.5%	17.9%	25%
Language father and child			
English	76.4%	53.6%	66.7%
French	9.1%	32.1%	0%
English and French	7.3%	0%	0%
Other	5.5%	14.3%	33.3%
Mother's education			
High school	9.1%	32.1%	36.4%
College	50.9%	50%	18.2%
University	40%	17.9%	45.5%
LD diagnosis			
Yes	5.5%	17.2%	15.4%
No	92.7%	82.8%	84.6%

Table 12

Descriptive Statistics for Participants' Characteristics in Grade 2

	Simplicity	Vocabulary	CSF
	Mean	Mean	Mean
Gender			
Girl	44.4%	41.2%	33.3%
Boy	55.6%	58.8%	66.7%
Mother L1			
English	44.4%	66.7%	53.3%
French	38.9%	33.3%	13.3%
Other	16.7%	0%	33.3%
Father L1			
English	52.9%	46.7%	46.7%
French	35.3%	40.0%	13.3%
Other	11.8%	13.3%	40.0%
Language mother and child			
English	55.6%	66.7%	80.0%
French	22.2%	13.3%	13.3%
English and French	16.7%	20.0%	0%
Other	5.6%	0%	6.7%
Language father and child			
English	50.0%	53.3%	80.0%
French	22.2%	33.3%	13.3%
English and French	22.2%	13.3%	0%
Other	5.6%	0%	6.7%
Mother's education			
High school	44.4%	6.7%	20.0%
College	33.3%	86.7%	46.7%
University	22.2%	6.7%	33.3%
LD diagnosis			
Yes	11.1%	13.3%	13.3%
No	88.9%	86.7%	86.7%

Table 13

Results of the One-Way ANOVA of PPVT raw scores by At-risk condition for Grade 1 and 2 Students

Variables	*SS*	*Df*	*MS*	*F*	*p*-value
PPVT Grade 1	24807.97	2	12403.99	1.35	.26
PPVT Grade 2	1143.53	2	571.77	.754	.48

Note. PPVT = Peabody Picture Vocabulary Test, $*p < .05$

Results of HLM Analyses for Grade 1 At-Risk Students in English

The research questions relate to cross-linguistic transfer, so it was essential to first consider how the students responded to the intervention in the language in which it was conducted. Accordingly, it was necessary to investigate the impact of the intervention on English literacy skills before addressing cross-linguistic transfer issues. If no improvement can be observed in the English reading and spelling scores (i.e. close transfer), it is then impossible to attribute any French improvement (i.e. far transfer) to cross-linguistic transfer. It would therefore be unnecessary to investigate cross-linguistic transfer in French outcomes. Savage, Georgiou, et al. (2017) established patterns for the full 2-province sample and reported no by-province interaction effects. However, to be absolutely sure that the same patterns applied to the Quebec only sample and to provide the cleanest contrasts, Quebec data alone are analyzed and reported below. If all groups are performing the same way at post-test in English, it would mean that the supplemental intervention did not have any special impact on at-risk students' reading skills when compared to the other experimental conditions. If the improvement is equivalent in each condition, it would then not be possible, with the chosen research design, to demonstrate the

existence of a causal relationship between learning in one language and transferring that knowledge to another language. Thus, participants' reading and spelling performance in English were first explored through HLM in order to evaluate the intervention's impacts on English skills as well as to demonstrate the possibility for cross-linguistic transfer to French.

Results for unconditional models. First, "null models" with no predictor were tested with each reading outcome in English in order to determine if there was significant between-group variance. Results indicated that there was significant classroom level variance at post-test and delayed post-test for each reading outcome. The ICCs reported in Table 14, show that between 9% and 29% of the total variance observed in reading performance can be explained by between classrooms differences. The presence of such variance confirms that multilevel hierarchical modeling was necessary to answer the research questions. The final estimation of fixed effects as well as the standard error are also presented for each reading outcome in Table 14.

Results of the one-way ANCOVA with fixed and random effects models. The between classroom variance was subsequently integrated in a final two-level random-coefficient model with level-1 and level-2 predictors (i.e. with students considered as level 1 and classrooms considered as level 2). Midtest WRAT scores were considered level-1 random covariates and experimental condition as a level-2 fixed effect. Separate models were tested for each reading outcome. The same models were also used to determine if significant differences existed between experimental groups at delayed post-test at the beginning of Grade 2 (i.e. following school year). Therefore, in the models, delayed post-test was used as the dependent variable and midtest WRAT scores were still used as a covariate. For the CTOPP-Segment outcome, the Hessian matrix could not converge, indicating that the covariate did not explain any variance.

Model 2, a random coefficient ANOVA model with a level 1 and a level 2 predictors was thus tested instead for this measure alone. Results for post-test and delayed post-test are reported in Table 15.

The small-group interventions focused on phonic work and set-for-variability, which taught students to use lexical knowledge as a strategy to read words they were unable to decode. As was specified by Savage, Georgiou, et al. (2017), with the pan-Canadian database, the WRAT and the WJ - Pseudoword reading were set as primary outcome measures, as they were the task reflecting more closely the content of the small-group interventions. Unadjusted alpha of $p < .05$ was thus used for these measures. All other measures were considered secondary outcomes and alphas adjustments were made for the total number of secondary outcomes ($\alpha = .05/3 = .02$ at post-test, $\alpha = .05/2 = .025$ at delayed post-test).

Table 14

Results for the One-Way ANOVA Model for Reading and Spelling Outcomes in English

Fixed Effects	ICC	*B*	*SE*	*t*-ratio	*d.f*	*p*-value
WRAT	0.21	22.27	0.82	27.066	56.46	<.001
FRY	0.09	11.58	0.68	17.15	18.33	<.001
CTOPP - Segment	0.13	8.42	0.53	15.79	23.25	<.001
WJ - SPELL	0.29	18.55	0.53	35.16	19.97	<.001
WJ - PSEUDO	0.22	7.25	0.60	12.08	27.50	<.001
DIBELS - PSF	0.17	38.96	2.36	16.48	22.49	<.001

Note. WRAT = Wide Range Achievement Test III, Reading subtest; FRY = 20 words from Fry high frequency word list; CTOPP - Segment = Comprehensive Test of Phonological Processing, Nonword segmentation subtest; WJ - Spell = Woodcock-Johnson III Test of Achievement, Spelling subtest; WJ - Pseudo = Woodcock-Johnson III Test of Achievement, Pseudoword reading subtest; DIBELS - PSF = DIBELS Phoneme Segmentation Fluency subtest

Table 15

HLM Results for the Effect of At-Risk Condition on Post-Test and Delayed Post-test Scores, Controlling for Midtest Attainment

Variable		Classroom-Level Model	
		Coefficient	*SE*
A) Post-test			
WRAT word reading Post = DV			
WRAT word reading Mid = CV			
Intervention	DMSfV	4.30*	1.74
	CBP	0.91	1.97
FRY word reading Post = DV			
WRAT word reading Mid = CV			
Intervention	DMSfV	0.65	1.68
	CBP	-0.35	1.92
CTOPP - Segment Post = DV			
WRAT word reading Mid = CV			
Intervention	DMSfV	0.48	0.71
	CBP	-1.29	0.36
WJ - Spelling Post = DV			
WRAT word reading Mid = CV			
Intervention	DMSfV	1.43^{+}	0.99
	CBP	-0.46	1.16
WJ - Pseudoword Post = DV			
WJ - Pseudoword reading Mid = CV			
Intervention	DMSfV	2.24^{+}	1.33
	CBP	0.14	1.35

Variable (continued)		Classroom-Level Model	
		Coefficient	*SE*
DIBELS - PSF Post = DV			
WRAT word reading Mid = CV			
Intervention	DMSfV	2.96	5.59
	CBP	-4.62	6.11
B) Delayed Post-test			
WRAT word reading Delayed Post = DV			
WRAT word reading Mid = CV			
Intervention	DMSfV	4.99*	2.09
	CBP	2.94	2.36
WJ - Spelling Delayed Post = DV			
WRAT word reading Mid = CV			
Intervention	DMSfV	2.83^{+}	1.18
	CBP	1.81	1.38
CTOPP - Segment Delayed Post = DV			
Intervention	DMSfV	4.23	2.18
	CBP	3.47	2.33
WJ - pseudoword reading Delayed Post = DV			
WJ - pseudoword reading Mid = CV			
Intervention	DMSfV	3.57*	1.77
	CBP	0.005	1.84

Note. WRAT = Wide Range Achievement Test III, Reading subtest; FRY = 20 words from Fry high frequency word list; CTOPP - Segment = Comprehensive Test of Phonological Processing, Nonword segmentation subtest; WJ - Spell = Woodcock-Johnson III Test of Achievement, Spelling subtest; WJ - Pseudo = Woodcock-Johnson III Test of Achievement, Pseudoword reading subtest; DIBELS - PSF = DIBELS Phoneme Segmentation Fluency subtest.

* $p < .05$, ** $p < .01$, $^{+}$ $p < .10$

The results of those multilevel ANCOVA show that the effect of experimental condition is significant at post-test in favor of the DMSfV condition for word reading (i.e. WRAT). However, the effect of condition was not significant for the CTOPP-Segment, the WJ - Spelling, the WJ - Pseudoword, the FRY and the DIBELS-PSF. At delayed post-test, at the beginning of Grade 2, a significant effect of experimental condition, in favor of the DMSfV, was still observed for the WRAT, indicating that students' progress was maintained. Additionally, a significant effect of condition was found for the WJ - Pseudoword reading. However, the effect of condition on the WJ - Spelling and on the CTOPP - Segment was not significant. The effect of experimental condition is thus more pronounced at delayed post-test, but shows that the small-group instruction in the DMSfV group had a significant effect on participants' reading and spelling skills in English.

Intervention effect size analysis. To better estimate the strength of the impact of the small-group interventions on English reading and spelling skills, effect sizes were calculated. Hedges' effect size was used as it is specifically intended for multilevel studies (Hedges, 2007). The effect sizes were therefore calculated on the basis of the following equation:

$$\delta_T = \frac{\mu^T - \mu^C}{\sigma_T} = \frac{\gamma_{01}}{\sqrt{\sigma^2} + \sqrt{\tau_{00}}}$$

In this equation, γ01 represents the mean difference between the target intervention group and the control group, while σ^2 and τ_{00} correspond to within- and between-group variance. The effect sizes relative to the impact of the G1 intervention in English are reported in Table 16. The largest effect sizes are observed for word reading (i.e. WRAT) as well as for the WJ - Pseudoword and are in favor of the DMSfV group. For the WJ - Spell, a smaller effect size was

also found, still in favor of the DMSfV condition. As for the other reading outcomes, effect sizes are too small to be considered noteworthy. Moreover, since no significant differences were found between groups for those outcomes, the null hypothesis cannot be rejected, suggesting that observed differences between group means may be due to chance. Thus, the small effect sizes related to those outcomes could also be attributed to chance, rather than representing the real impact of the intervention on students' performance. At delayed post-test, considerable effect sizes are observed for all reading outcomes; WRAT, DIBELS - PSF, CTOPP - Segment and WJ - Pseudoword, all in favor of the DMSfV condition, indicating the positive long-term impacts of the small-group intervention on English reading and spelling skills of that experimental condition.

Cross-linguistic transfer. The results of the previous analyses demonstrate the positive impact of the DMSfV intervention on the reading skills of participants in English. Thus, it indicates that close transfer (i.e. within the same language) was achieved and that participants of one the DMSfV condition made significant progress in reading and spelling in English, compared to the participants in the other experimental conditions. The fact that this group was significantly different from the others and that participants were able to transfer what they had learned when completing reading and spelling tasks in English allowed us to investigate if that progress was also visible in French. In other words, the results made it possible to explore the issue of cross-linguistic transfer (i.e. far transfer) from English to French.

Table 16

Small-group Intervention's Effect sizes (Hedge's δ) of English Reading and Spelling Outcomes in Grade 1

	DMSfV		CBP	
Measure	Post-test	Delayed Post-test	Post-test	Delayed Post-test
WRAT	0.50	0.56	0.10	0.33
FRY	0.09	-	-0.05	-
CTOPP - Segment	0.09	0.52	-0.23	0.43
WJ - Spell	0.28	0.50	-0.09	0.32
WJ - Pseudoword	0.39	0.48	0.02	< 0.00
DIBELS - PSF	0.12	-	-0.19	-

Note. WRAT = Wide Range Achievement Test III, Reading subtest; FRY = 20 words from Fry high frequency word list; CTOPP - Segment = Comprehensive Test of Phonological Processing, Nonword segmentation subtest; WJ - Spell = Woodcock-Johnson III Test of Achievement, Spelling subtest; WJ - Pseudo = Woodcock-Johnson III Test of Achievement, Pseudoword reading subtest; DIBELS - PSF = DIBELS Phoneme Segmentation Fluency subtest.

Results of HLM Analyses for Grade 1 At-Risk Students in French

Results for unconditional models. First, the unconditional models were tested in order to determine if there was significant between-groups variance in the various reading outcome measures. Results are presented in Table 17. For every reading outcome, the ICC, as well as the final estimation of fixed effects with standard errors are reported. The ICCs indicate that there is considerable classroom level variance at post-test for each of the outcome measures, with between 18% and 42% of the total variance in the various reading outcome measures accounted

for by differences between classrooms. Those results show that the assumption of independence of errors is violated and thus, that multilevel hierarchical modeling is the appropriate analysis to investigate the data.

Table 17

Results for the One-Way ANOVA Model for French Reading Outcomes in Grade 1

Fixed Effects	ICC	*B*	*SE*	*t*-ratio	*d.f*	*p*-value
PA	0.18	12.38	0.77	16.04	17.82	<.001
Irregular	0.27	2.43	0.53	4.61	24.10	<.001
Regular	0.36	7.60	1.30	5.843	21.71	<.001
Nonwords	0.40	9.90	1.25	7.90	20.20	<.001
GPC	0.42	5.06	0.72	6.99	20.87	<.001

Note. PA = Phonological awareness – Blending task; Irregular = Irregular word list; Regular = Regular word list (simple graphemes only); Nonwords = experimental nonwords list (Grade 1); GPC = Grapheme to phoneme conversion task.

Results for research question 1. This study seeks to determine the impacts of a preventative and supplemental intervention in English on the transfer of decoding skills in French among at-risk children in Grade 1. To answer the research question mentioned above, the means of the three experimental groups were compared for each different reading outcome in French. Those group comparisons were necessary in order to determine whether significant differences existed between conditions. Thus, a final two-level model with level-1 and level-2 predictors (i.e. with students considered as level 1 and classrooms considered as level 2) was tested with midtest scores as a level-1 random covariate and experimental condition as a level-2

fixed effect. Separate models were conducted for each reading outcome. However, for the outcome of irregular word reading, no covariate was used in the model since no variance existed ($p > .05$) between at-risk groups at midtest. Model 2, a random coefficient ANOVA model with a level 1 and a level 2 predictors was thus tested instead for this variable only. Results are reported in Table 18.

As for the English outcomes, measures of words and nonwords were considered to reflect best the work done in the small-group interventions. The regular word and nonword tests were thus set as primary outcome measures and an unadjusted alpha of $p < .05$ was thus used for these measures. All other measures were considered secondary outcomes and alphas adjustments were made for the total number of secondary outcomes ($\alpha = .05/ 3 = .02$)

The results of the multilevel ANCOVA with random coefficients demonstrate that, after controlling for midtest attainment (except for irregular word reading), there are significant differences ($p < .05$) between groups at post-test for the regular and nonword reading primary outcomes. There are also significant ($p < .02$) differences between groups for irregular word reading. However, no significant differences between groups are found for the outcomes of phonological awareness and grapheme to phoneme conversion outcomes with the adjusted alpha. The effect of condition on those outcomes would however be significant at $p = .05$.

Table 18

HLM Results for the Effect of Condition on Post-Test Scores, Controlling for Midtest Attainment

Variable		Classroom-Level Model	
		Coefficient	*SE*
PA (blending task) post-test = DV			
Phonological awareness Midtest = CV			
Intervention	DMSfV	3.66*	1.64
	CBP	0.58	1.76
Irregular word reading post-test = DV			
Intervention	DMSfV	2.91*	1.19
	CBP	-0.27	1.24
Regular word reading post-test = DV			
Regular word reading Midtest = CV			
Intervention	DMSfV	1.94*	1.85
	CBP	-0.38	1.98
Nonword reading post-test = DV			
Nonword reading Midtest = CV			
Intervention	DMSfV	2.80*	2.13
	CBP	-1.47	2.22
GPC reading post-test = DV			
GPC reading Midtest = CV			
Intervention	DMSfV	1.33*	1.21
	CBP	-1.02	1.18

Note. PA = Phonological awareness – Blending task; Irregular = Irregular word list; Regular = Regular word list (simple graphemes only); Nonwords = experimental nonwords list (Grade 1); GPC = Grapheme to phoneme conversion task.

* $p < .05$, ** $p < .01$, $^{+}$ $p < .10$

Intervention effect size analysis. To further evaluate the practical impact of the intervention on cross-linguistic transfer, effect sizes were calculated and are reported in Table 19. Once again, Hedges' effect size was preferred to estimate the impact of the small-group instruction in French, since it is specifically intended for multilevel studies (Hedges, 2007). Results reported in Table 19 show that effect sizes are larger for the DMSfV interventions across the majority of post-test measures. Specifically, the effect sizes of 0.59 for irregular word reading and 0.48 for phoneme blending reflect a clear and important impact for the DMSfV intervention on French reading. Smaller effect sizes can also be observed for regular word reading whereas the effect sizes for nonword reading and grapheme to phoneme conversion task are the smallest.

Table 19

Effect sizes (Hedge's δ) for French Reading for Each Experimental Condition in Grade 1

	DMSfV	CBP
Measure	Post-test	
Phonological awareness (Blending task)	0.48	0.08
Irregular words	0.59	0.11
Regular Words	0.37	-0.03
Nonwords	0.25	-0.14
GPC	0.21	-0.16

Note. PA = Phonological awareness – Blending task; Irregular = Irregular word list; Regular = Regular word list (simple graphemes only); Nonwords = experimental nonwords list (Grade 1); GPC = Grapheme to phoneme conversion task.

Results for research question 2. One of the most frequent questions about cross-linguistic transfer concerns what actually transfers across languages. The present study was designed to demonstrate the presence of cross-linguistic transfer and then enable the analysis of what was transferred between English and French. Since there is reasonable preliminary evidence of the presence of cross-linguistic transfer, it was possible to move a step forward and take a look at the nature of the knowledge that was transferred. More precisely, multilevel analyses (i.e. multilevel ANCOVA) were conducted to attempt to determine whether transfer occurred at the level of specific knowledge (e.g. specific GPC) or at the more general level of process (e.g. decoding principles). To do so, errors made by the participants during nonword reading were analyzed. As mentioned previously, each error made by students was qualitatively coded according to the linguistic aspect affected by the error (e.g. phonology or GPC knowledge). The different types of error were then sorted in one of the following categories: errors associated with inaccurate knowledge of specific French GPC (resulting in phoneme substitution) or errors linked to inaccurate phonological skills (resulting in phoneme deletion, addition or displacement). Both accurate GPC knowledge and efficient phonological skills are needed in order to decode nonwords accurately. However, GPCs represent knowledge that is partly specific to a language whereas in a general sense, phonological abilities such as phoneme segmentation or blending represent skills that are generalizable to reading in all alphabetic languages. These two categories of errors explained 66.8% of all errors and midtest, and 78.19% of all errors at post-test. Errors that were not coded within those two categories mainly concerned: 1) Students saying letters' names instead of letters' sound or 2) Students having improper morphological knowledge leading to read silent letters at the end of French words (e.g. reading "chat" (/ʃa/) as /ʃat/). The proportion of errors (number of errors in a category/ total

number of errors) in each category was calculated for each child. Unfortunately, within the scope of this doctoral project, it was not possible to carry out inter-rater coding. HLM analyses were used in order to evaluate the impact of the intervention on each type of error and thus to seek an answer to our second research question.

Results for unconditional models. The models used to answer question 1 were also used to answer research question 2. Thus, in order to determine if there was significant between-groups variance in the proportion of errors for nonword reading, unconditional models were first tested. The results for those "null" models with no predictors are reported in Table 20. They show that there exist significant between-classroom variance relatively to the proportion of GPC errors whereas almost none exists for the proportion of phonological errors.

Table 20

Results of the One-Way ANOVA Model for the Effect of Condition on Proportion of errors

Fixed Effects	ICC	*B*	*SE*	*t*-ratio	*d.f*	*p*-value
Phono. errors	0.015	25.06	1.29	19.372	13.86	<.001
GPC errors	0.08	15.16	1.91	27.797	19.90	<.001

Note. Phono. errors = errors relative to phonology (phoneme addition, deletion, displacement); GPC errors = errors relative to grapheme to phoneme conversion.

Results for research question 2. The results of the unconditional model indicated that multilevel analysis ought to be conducted only with the proportion of GPC errors. Therefore, a final two-level model (students as level-1 variables and classrooms as level-2 variables) was tested. Results are reported in Table 21. The multilevel ANCOVA showed that there was no

significant effect of condition on the proportion of GPC errors in students' nonword reading. Therefore, students' proportion of error relative to GPC knowledge (i.e. phoneme substitution) at post-test were not significantly different between groups. Those results suggest that the intervention did not especially facilitate the cross-linguistic transfer of specific GPC knowledge from English to French.

As presented earlier, the unconditional model indicated there was almost no between classroom variance in the proportion of phonological errors in students' reading. The Hessian matrices also did not converge for any multilevel model. A simple one-way ANCOVA was thus conducted. As can be seen in Table 22, results indicate there is a significant effect of condition on the proportion of phonological errors in students' nonword reading. The means of the different conditions (DMSfV = 25.90, CBP = 21.47, CSF = 32.72) indicate that the control group is where students make the most phonological errors. Post-hoc analyses show that the students in the control condition are making a significantly greater proportion of errors relative to phonology (phoneme addition, deletion and displacement) at post-test, when controlling for midtest, when compared to the CBP group. However, this difference is not significant for the DMSfV group.

Table 21

HLM results for the Effect of Condition on Proportion of GPC Errors at-Post-Test, Controlling for Midtest

Variable	Classroom-Level Model	
	Coefficient	*SE*
GPC errors = D.V.		
GPC errors Midtest		
Experimental condition		
1 DMSfV	3.10	4.82
2 CBP	2.62	5.09

Note. GPC errors = Proportion of errors relative to grapheme to phoneme conversion.

* $p < .05$, ** $p < .01$, $^{+}$ $p < .10$

Table 22

One-Way Analysis of Covariance for the Effect of Condition on Proportion of Phonological Errors at Post-Test, Controlling for Midtest

Fixed Effects	*SS*	*Df*	*MS*	*F*	*p*-value
Condition	989.28	2	494.64.25	4.00	0.02*
Phono. errors Midtest	186.99	1	186.99	1.51	0.22
Condition* Phono. errors midtest	169.63	2	84.82	0.69	0.51

Note. Phono. errors = proportion of errors relative to phonology

* $p < .05$

Effect size analysis. Effect sizes were calculated and results are reported in Table 23 and Table 24. In relation to the proportion of GPC errors, both the means (DMSfV = 55.21, CBP = 55.22, CSF = 52.40) and the effect sizes suggest that none of the small-group interventions led to

superior performance in the proportion of GPC errors. Indeed, proportions of GPC errors at post-test are comparable in each group. On the other hand, means (DMSfV = 26.87, CBP = 22.75, CSF = 32.72) and effect sizes relative to the proportion of phonological errors suggest that the intervention led to a difference in students' performance. Indeed, since the proportion of errors rather than proportion of accurate answers was measured, greater effect sizes indicate an increase of errors in that area, which is the opposite of the objective of the small-group interventions. Therefore, the far greater effect size of the control group indicates that the proportion of phonological errors made by those students increased considerably more than for students in the two experimental groups. Thus, the results suggest that the small-group intervention, particularly the CBP one, contributed to maintaining a smaller proportion of phonological errors when reading nonwords.

Table 23

Effect Sizes (Hedge's δ) Relative to the Proportion of GPC errors for Each Experimental Condition

	DMSfV	CBP
Measure	Post-test	
GPC errors	0.32	0.39

Note. Phono. errors = proportion of errors relative to grapheme to phoneme conversion.

Table 24

Effect Sizes (Cohen's δ) Relative to the Proportion of phonological errors for Each Experimental Condition

	DMSfV	CBP	CSF
Measure		Post-test	
Phono. errors	0.57	0.24	1.30

Note. Phono. errors = proportion of errors relative to phonology.

In sum, the results of the HLM analysis as well as the effect sizes seem to suggest that cross-linguistic transfer occurred to a greater degree at the more general level of decoding mechanism than at the more specific level of GPC knowledge.

Results of HLM Analyses for Grade 2 At-Risk Students

Multilevel modeling was also used to answer the research questions concerning the Grade 2 at-risk students. The main research question seeks to determine the impacts of a preventative and supplemental intervention based on the "simplicity principle" in English on the cross-linguistic transfer of decoding and spelling skills in French among Grade 2 at-risk children. To answer that question, HLM models described earlier in the result section were used.

Results of HLM Analyses for Grade 2 At-Risk Students in English

As for the Grade 1 results, it was important to first consider how the students responded to the intervention in the language of instruction (i.e. English) before addressing cross-linguistic transfer to French.

Results for unconditional models. First, "null models" with no predictor were tested with each reading outcome in English in order to determine if there was significant between-

group variance. The ICC as well as the final estimation of fixed effects and the standard errors of every unconditional model are reported in Table 25. The results demonstrate that between 0% and 10% of the total variance observed in reading and spelling performance in English at post-test in Grade 2 and at delayed post-test at the beginning of Grade 3 can be explained by classroom differences. When classroom variance was present, multilevel hierarchical modeling was considered the appropriate way to analyse the data. However, for the WJ - Pseudoword at post-test, classroom variance was smaller than 0.01. The same was observed for three outcomes at delayed post-test (i.e. WRAT, WJ - Pseudoword, WJ - Spelling), indicating that little variance exists between classrooms in general at the beginning of Grade 3. Those results indicate that regular multivariate analyses were a more appropriate way to analyse data for these variables only.

Table 25

Results of the One-Way ANOVA Model for Reading and Spelling Outcomes in English in Grade 2

Fixed Effects	ICC	*B*	*SE*	*t*-ratio	*d.f*	*p*-value
Post-test						
WRAT	0.03	26.28	0.97	27.23	16.74	<.001
CTOPP - Blend	0.07	23.54	0.94	25.16	10.03	<.001
WJ - SPELL	0.08	21.68	0.55	39.23	14.07	<.001
WJ - PSEUDO	< 0.00	-	-	-	-	-
DIBELS -RF	0.03	38.04	3.28	11.61	14.21	<.001
Delayed Post-test						
WRAT	< 0.00	-	-	-	-	-
WJ-SPELL	< 0.00	-	-	-	-	-
WJ-PSEUDO	< 0.00	-	-	-	-	-
DIBELS - RF	0.04	44.04	4.40	10.03	13.67	<.001

Note. WRAT = Wide Range Achievement Test III, Reading subtest; CTOPP - Blend = Comprehensive, Test of Phonological Processing, Blending Words subtest; WJ - Spell = Woodcock-Johnson III Test of Achievement, Spelling subtest; WJ - Pseudo = Woodcock-Johnson III Test of Achievement, Pseudoword reading subtest; DIBELS - RF = DIBELS Reading Fluency subtest.

Results of the one-way ANCOVA with fixed and random effects models. For post-test and delayed post-test outcomes with an ICC superior to 0.01, between classroom variance was integrated in a final two-level random-coefficient model with level-1 and level-2 predictors (i.e.

with students considered as level 1 and classrooms considered as level 2). Midtest WRAT scores were considered level-1 random covariates and experimental condition as a level-2 fixed effect. Separate models were tested for each reading outcome. When testing the model for CTOPP - Blending at post-test, the Hessian matrix failed to converge, indicating that the covariate did not explain any variance in the model. A multilevel ANOVA with a level 1 and a level 2 predictor was thus used instead. The same approach was applied for the DIBELS - RF outcome at delayed post-test. Results of the multilevel analyses for post-test and delayed post-test outcomes are reported in Table 26.

As in Grade 1, the WRAT and the WJ - Pseudoword reading were set as primary outcome measures and an unadjusted alpha of $p < .05$ was thus used for these measures. All other measures were considered secondary outcomes and alphas adjustments were made for the total number of secondary outcomes ($\alpha = .05/3 = .02$ at post-test, $\alpha = .05/2 = .025$ at delayed post-test)

Results of the ANCOVA analyses. For outcomes where between-classroom variance was inferior to 0.01, regular multivariate statistics were used to determine if there were significant differences between at-risk conditions at post-test and delayed post-test. First, to determine if significant differences ($p < .05$) existed between conditions at midtest, regular analysis of variance were conducted for each of the outcomes. Significant differences at midtest were not found for any of the outcomes. Thus, it was concluded that midtest scores did not need to be used as covariates in the models. Other ANOVAs were thus conducted with post-test as the dependent variable and at-risk group as the independent variable. Results are reported in Table 27.

Table 26

HLM Results for the Effect of At-Risk Condition on Post-Test and Delayed Post-Test Scores

Variable		Classroom-Level Model	
		Coefficient	*SE*
A) Post-test			
CTOPP - Blend Post = DV			
Intervention	Simplicity	2.50	2.10
	Vocabulary	0.81	2.12
WJ - Spelling Post = DV			
WJ - pseudoword reading Mid = CV			
Intervention	Simplicity	0.30	1.28
	Vocabulary	-1.33	1.27
DIBELS - RF Post = DV			
DIBELS - RF Mid = CV			
Intervention	Simplicity	2.93	7.87
	Vocabulary	-7.22	7.66
B) Delayed Post-test			
DIBELS - RF Delayed Post = DV			
Intervention	Simplicity	1.59	12.06
	Vocabulary	5.68	11.39

Note. CTOPP - Blend = Comprehensive, Test of Phonological Processing, Blending Words subtest; WJ - Spell = Woodcock-Johnson III Test of Achievement, Spelling subtest; DIBELS - RF = DIBELS Reading Fluency subtest.

* $p < .05$, ** $p < .01$, $^{+}p < .10$

Table 27

One-Way Analysis of Variance for the Effect of At-Risk Condition on Post-Test and Delayed Post-Test Scores

Fixed Effects	*SS*	*Df*	*MS*	*F*	*p*-value
A) Post-test					
WRAT	194.150	1	97.08	2.22	.119
WJ - Pseudoword	76.74	2	38.37	1.38	.262
B) Delayed Post-test					
WRAT	23.00	2	11.50	2.94	.747
WJ - Pseudoword	5.50	2	2.75	.110	.896
WJ - Spelling	0.010	2	0.01	0.00	1.00

Note. WRAT = Wide Range Achievement Test III, Reading subtest; WJ - Pseudo = Woodcock-Johnson III Test of Achievement, Pseudoword reading subtest; WJ - Spell = Woodcock-Johnson III Test of Achievement

* $p < .05$

The results of the multilevel and regular analyses presented in the tables above show that the effect of experimental condition was not significant for any of the English reading or spelling outcomes. Thus, the reading and spelling performance of students participating in either small-group intervention were not different from the ones of the students in the control group. Therefore, this suggests that the small-group interventions were not sufficient to improve students' reading and writing skills more than regular teaching alone, which the three groups were exposed to. However, the small sample size, which influences statistical power, might have precluded the finding of significant statistical differences between groups.

Intervention effect size analysis. Even though no significant differences were found between groups, effect sizes were calculated to better estimate the strength of the impact of the small-group interventions on English reading and spelling skills. Hedges' effect size was used for outcomes for which multilevel analyses were possible. For outcomes for which it was not the case, Cohens' effect size was used. Hedges' effect sizes are presented in Table 28 and Cohens' ones are presented in Table 29. In Table 28, a non-negligible effect size in favor of the Simplicity intervention can be observed for CTOPP - Blending. Inspection of effect sizes for spelling and reading fluency suggest that none of the interventions had a practically meaningful impact on students' performance. Results in Table 29 show important effect sizes for the Simplicity intervention for both word and pseudoword reading. More specifically, the effect size of 1.52 observed for pseudoword reading reflects a clear and important impact of the Simplicity intervention on English reading. The effect size for the WRAT, however, is smaller.

Table 28

Effect sizes (Hedge's δ) for English Outcomes for Each Experimental Condition in Grade 2

	Simplicity	Vocabulary
Measure	Post-test	
CTOPP - Blend	0.33	-0.11
WJ - Spelling	-0.09	-0.28
DIBELS - RF	0.11	-0.27

Note. CTOPP - Blend = Comprehensive, Test of Phonological Processing, Blending Words subtest; WJ - Spell = Woodcock-Johnson III Test of Achievement; Spelling subtest; DIBELS - RF = DIBELS Reading Fluency subtest.

Table 29

Effect sizes (Cohen's δ) for English Outcomes for Each Experimental Condition in Grade 2

	Simplicity	Vocabulary	Control
		Post-test	
WRAT	1.41	0.64	1.18
WJ - Pseudoword	1.52	0.66	0.45

Note. WRAT = Wide Range Achievement Test III, Reading subtest; WJ - Pseudo = Woodcock-Johnson III Test of Achievement, Pseudoword reading subtest.

Cross-linguistic transfer. The results of the previous analyses do not demonstrate the existence of any significant impact of the intervention on the English reading and spelling skills of Grade 2 participants. Therefore, it suggests that close transfer (i.e. within the same language) was not achieved. Accordingly, it was not possible to show the presence of a causal relationship between the small-group intervention and participants' performance in English. Thus, any evidence about cross-linguistic transfer should be interpreted with caution. However, the results of the multilevel analyses for Grade 2 reading and spelling outcomes in French are still presented below. Indeed, transfer is not explicitly expected in French. However, it is a more transparent language than English. Consequently, the possibility of students applying what they learned to French cannot be entirely dismissed. Additionally, consistency between results in English and French would provide support in favor of the validity of the findings.

Results of HLM Analyses for Grade 2 At-Risk Students in French

Results for unconditional models. The results of the unconditional models show that there is significant variation between classrooms' mean performance in word reading but not in

spelling or fluency. ICCs were calculated in models where between-classroom variance was observable. Results indicate that between 0% and 18% of the total variance in the various reading outcome measures is accounted for by differences between classroom means. Even though those ICCs are substantively smaller than the ones obtained for the Grade 1 intervention, they still constitute evidence of non-independence in the data and thus, provide support for the use of HLM. The results of the One-Way ANOVA Models with Random Effects are presented in Table 30. For every reading outcome, results for final estimation of fixed effects with standard errors are reported.

As reported earlier, when testing the unconditional models for the spelling and fluency outcome measures, the Hessian matrices did not converge and indicated that between-group variance did not explain any variance in the models. Between-group differences were thus explored through a normal ANCOVA.

Table 30

Results for the One-Way ANOVA Model with Random Effects for French Reading Outcomes in Grade 2

Fixed Effects	ICC	*B*	*SE*	*t*-ratio	*d.f*	*p*-value
Irregular	0.04	3.68	0.67	5.47	15.88	<.001
Regular	0.10	7.58	1.43	5.31	16.46	<.001
Nonwords	0.08	11.33	1.16	9.80	17.17	<.001
GPC	0.18	5.79	0.72	8.02	16.71	<.001
Spelling	< 0.00	9.98	0.76	13.18	48	<.001
Fluency	< 0.00	26.06	2.21	11.77	48	<.001

Note. Irregular = Irregular word list; Regular = Regular word list (simple graphemes only); Non-words = experimental nonwords list (Grade 2); GPC = Grapheme to phoneme conversion task; Spelling = experimental nonwords list; Fluency = Test de Marie (reading fluency rate).

Results for research question 1. As in Grade 1, the main research question regarding the Grade 2 intervention was the following: what are the impacts of a preventative and supplemental intervention in English based on the "simplicity principle" on the transfer of decoding skills in French among at-risk children?

A final two-level model with level-1 and level-2 predictors (i.e. with students considered as level 1 and classrooms considered as level 2) was tested with midtest scores as a level-1 random covariate and experimental condition as a level-2 fixed effect. Separate models were conducted for each reading outcome. Results are reported in Table 31. As mentioned previously,

no between-classroom variance existed for outcomes of reading fluency and nonword spelling and thus, results of a simple analysis of covariance are reported in Table 32.

As for the Grade 1 results, the regular word and nonword reading outcomes were set as primary outcome measures and an unadjusted alpha of $p < .05$ was used for these measures. All other measures were considered secondary outcomes and alphas adjustments were made for the total number of secondary outcomes ($\alpha = .05/4 = .013$)

Results of the multilevel ANCOVA with random effects demonstrate that, after controlling for midtest differences, there are no significant differences between experimental conditions at post-test across all reading outcomes. The results of the simple ANCOVA demonstrate the same thing for the fluency and nonword spelling outcomes.

In sum, results regarding French reading and spelling outcomes are consistent with the ones for English outcomes. In both cases, no significant differences are found between the different conditions. Thus, it suggests that the small-group interventions did not improve at-risk students' reading and spelling performance more than regular teaching in either language.

Table 31

HLM Results for the Effect of Intervention Condition on Post-Test Scores, Controlling for Midtest scores

Variable		Classroom-Level Model	
		Coefficient	*SE*
Post-test			
Irregular word reading post-test = DV			
Irregular word reading Midtest = CV			
Intervention	Simplicity		
	Vocabulary	1.38	1.25
		0.10	1.08
Regular word reading post-test = DV			
Regular word reading Midtest = CV			
Intervention	Simplicity	1.07	1.78
	Vocabulary	-0.67	1.68
Nonword reading post-test = DV			
Nonword reading Midtest = CV			
Intervention	Simplicity	2.22	2.06
	Vocabulary	1.90	2.05
GPC reading post-test = DV			
GPC reading Midtest = CV			
Intervention	Simplicity	0.83	1.18
	Vocabulary	1.38	1.11

Note. Irregular = Irregular word list; Regular = Regular word list (simple graphemes only); Nonword = experimental nonwords list (Grade 2); GPC = Grapheme to phoneme conversion task.

* $p < .05$, ** $p < .01$, $^{+}$ $p < .10$

Table 32

One-Way Analysis of Covariance for the Effect of Condition on Fluency and Pseudoword Spelling Post-Test Scores, Controlling for Midtest scores

Fixed Effects	*SS*	*Df*	*MS*	*F*	*p*-value
Spelling (DV)					
Condition	7.20	2	3.60	0.52	0.60
Fluency (Midtest)	809.92	1	809.92	115.89	< .001
Condition* Fluency (Midtest)	4.65	2	2.32	0.33	0.72
Fluency Post-test (DV)					
Condition	119.92	2	59.96	1.53	0.23
Fluency (Midtest)	7296.75	1	7296.75	186.23	< .001
Condition* Fluency (Midtest)	199.79	2	99.90	2.55	0.09

Note. Spelling = experimental nonwords list; Fluency = Test de Marie (reading fluency rate)

Intervention effect size analysis. Table 33 present Hedge's effect sizes for each experimental condition. Since multilevel modeling could not be used for the outcomes of fluency and spelling, Cohens' d, rather than Hedges' δ was calculated and are presented in Table 34. A meaningful effect size can be observed for irregular words reading for the Simplicity intervention. However, this effect size concerns an outcome for which no considerable effect size was found in English; its relevance as a measure of transfer is thus questionable. Also, effect sizes for regular, words, nonwords, fluency and spelling are very similar for both experimental groups, indicating that none of the small-group intervention led to superior performance in those outcomes.

Table 33

Effect sizes (Hedge's δ) for French Outcomes for Each Experimental Condition in Grade 2

	Simplicity	Vocabulary
Measure	Post-test	
Irregular words	0.26	0.02
Regular Words	0.09	-0.06
Nonwords	0.24	0.21
GPC	0.14	0.24

Note. Irregular = Irregular word list; Regular = Regular word list (simple graphemes only); Nonwords = experimental nonwords list (Grade 2); GPC = Grapheme to phoneme conversion task.

Table 34

Effect sizes (Cohen's δ) for French Outcomes for Each Experimental Condition in Grade 2

	Simplicity	Vocabulary
	Post-test	
Spelling	0.67	0.65
Fluency	0.19	0.19

Note. Spelling = experimental nonwords list; Fluency = Test de Marie (reading fluency rate).

Results for research question 2. This study was designed to evaluate the presence of cross-linguistic transfer and then enable the analysis of what was transferred between English and French. However, because it was not possible to demonstrate the presence of cross-linguistic

transfer on nonword reading following the preventative intervention, it unfortunately became impossible to further analyse the nature of what was transferred between English and French.

Chapter V: Discussion

The present research aimed to investigate cross-linguistic transfer among Grade 1 and Grade 2 students attending French Immersion (French/English) bilingual elementary schools. More specifically, the study evaluated the impact of a preventative literacy intervention in English on French literacy skills of at-risk students who performed below the 30th percentile on standardized word reading tests in English at midtest. Findings of the multilevel analyses are discussed in relation to theories of cross-linguistic transfer and existing scientific research related to reading intervention and transfer. The following chapter will also address the limitations of the research, its unique contribution to the fields of cross-linguistic transfer and biliteracy and will conclude by presenting suggestions for future research.

Findings

Research question 1: The first research question sought to investigate cross-linguistic transfer among Grade 1 and Grade 2 students who were found to be at-risk of developing reading difficulties on the basis of word reading tests in English. We asked - what are the impacts of a preventative and supplemental intervention delivered in English on the cross-linguistic transfer of decoding and spelling skills in French among students identified as at-risk in English?

To answer question 1 adequately, it was necessary to first explore the impact of the small-group interventions on students' reading and spelling skills in English, before considering the possibility of cross-linguistic transfer to French. The present study was embedded in a larger larger multi-province study (Savage, Georgiou, et al., 2017) aiming to investigate the impact of a preventative intervention carried out in English on English reading skills of elementary school students enrolled in French Immersion programs in Quebec and in Alberta. The multi-province analyses reported by Savage, Georgiou, et al. (2017) showed the overall positive impacts of the

intervention in English as well as the absence of effect for Province per se. However, the effects for Quebec students only still needed to be isolated and confirmed, so that they could then be compared to students' performance in French. Reading and spelling outcomes in English and in French were thus explored to determine the impact of the small-group interventions.

Because of the nested nature of our data, the first necessary step in model building was to test unconditional models with no predictors. Results indicated that there was significant between classroom variation for most of the reading outcomes in both languages in Grade 1 and in Grade 2. Hierarchical modeling was thus considered necessary to analyze data adequately.

The between-classroom variance identified through the unconditional models was subsequently integrated within individual and classroom level models. Final models were then tested to investigate the impact of experimental condition on a given reading outcome at post-test while controlling for midtest differences. Three experimental conditions were compared in each grade. Two of those focused on reading instruction while the third one, which acted as a control condition, aimed to teach curricular and socio-emotional skills. Separate multilevel models were run for each outcome in Grade 1 and in Grade 2. Results of the analyses yielded significant findings.

Results for Grade 1. In Grade 1, the results of the multilevel analyses regarding the English measures showed some significant effects for the DMSfV small-group intervention. Indeed, at post-test, the effect of at-risk condition was significant for the Word Reading subtest of the Wide Range Achievement Test III (WRAT). No other significant effect was observed. At-delayed post-test, a significant effect of at-risk condition was found for the WRAT and the

Woodcock Johnson (WJ) pseudoword reading outcomes, again in favor of the DMSfV intervention.

Effect size analyses for hierarchical models also show a similar pattern of advantage for the DMSfV condition. At post-test, an effect size of 0.50 was noted for the WRAT. Effect sizes of 0.28 and 0.39 were also respectively observed for the pseudoword and spelling subtests of the WJ III Test of achievement, always in favor of the DMSfV condition. At delayed post-test, effect sizes of 0.56 and 0.48 were found for the WRAT and the WJ - Pseudoword reading, respectively. Effect sizes equal or superior to 0.50 were also noted for the CTOPP-Segmenting and WJ - Spelling outcome measures.

Using Cohen's (1988) metric for interpreting effect sizes, which is quite common in the literature, all the previously mentioned effect sizes can be considered as small (0.20) to medium (0.50). Recently, Lipsey et al. (2012) have, however, questioned the uncritical use of this metric and argue that it was not tailored to the effect of some intervention studies in education and other disciplines. Thus, Lipsey et al. (2012) suggest that effect sizes obtained in similar prior intervention studies should act as benchmarks. Therefore, an effect of 0.25 could be considered as "large" if most prior intervention studies in the same field obtained effect sizes of 0.10, for example. Interpreting effect sizes this way would, however, make it harder to compare the magnitude of effect sizes across areas. Additionally, it would potentially affect the interpretation of the impact of an intervention. Indeed, if an effect of 0.25 is considered as large, the intervention to which it is related might be considered as highly effective, even though it only led to small changes in students' performance. There could be an argument for seeing small effects as "large" with at-risk students who have made modest progress. However, the present study aimed to prevent reading difficulties among at-risk students and help them catch up with other

students of their classroom. Thus, for this goal to become a reality, medium to large effect sizes are required, meaning important changes are observable in students' performance. Consequently, Cohens' metric will be preferred to interpret effect sizes within this study. Therefore, effect sizes, specifically at delayed post-test, suggest that the DMSfV intervention had a moderate impact on students' performance in word reading and phonological awareness in English.

Since both the *p*-values and the effect sizes of analyses on the English language data suggested that the DMSfV small-group intervention had a considerable positive impact on at-risk students' phonological awareness, reading and spelling skills in English, cross-linguistic transfer to French was explored. Results of HLM analyses showed that the effect of experimental condition was significant for the following French reading outcomes at post-test: Irregular word reading, regular word reading and nonword reading. Thus, for those outcomes, students in the DMSfV small group performed significantly better than students in the other conditions. For the outcomes of phonological awareness (blending task) and grapheme to phoneme conversion task, no significant between group differences were found with the adjusted $p = .02$. However, those differences would have been significant at an unadjusted $p = .05$. The effect sizes also indicated an advantage for the DMSfV intervention program in all of the reading outcomes. Nonetheless, the magnitude of the effect sizes was different for the different outcomes. Indeed, medium effect sizes above 0.48 were observed for irregular word reading and phonological awareness, whereas effect sizes of 0.37 and 0.25 respectively were noted for regular and nonword reading. For the grapheme to phoneme conversion task, a smaller effect size of 0.21 was observed. As for English performance, effect sizes relative to French outcomes indicate that the DMSfV intervention had a moderate impact on students' performance in word reading and phonological awareness.

In sum, in Grade 1 the concordance between the results of the multilevel analyses in English and French could arguably be meaningfully associated with the concept of cross-linguistic transfer. This conclusion is drawn from the finding that significant additional improvements were observed in both phonological awareness and word reading in English and in French for the DMSfV condition, despite the fact the intervention occurred only in one language, and where the most obvious confounds such as quality of regular classroom teaching did not differ significantly. Moreover, improvement in French was observed immediately following the small-group intervention, suggesting that transfer was immediate. Therefore, the present results could thus be considered as preliminary evidence of the presence of cross-linguistic transfer. Findings are also in line with previous correlational research indicating the presence of a strong relationship between L1 and L2 phonological awareness (Bialystok, McBride-Chang et al., 2005; Chen et al., 2004; Comeau et al., 1999; Kruk & Reynolds, 2012; Wade-Woolley & Geva, 2000; Snow, 2008) and word and pseudoword reading (Abu-Rabia, 1997; Bialystok et al., 2005; Da Fontoura & Siegel, 1995; Durgunoglu et al., 1993; Snow, 2008; Wade-Wooley & Geva, 2000) skills. The present findings are also in line with Wise et al. (2015)'s intervention study showing that phonological awareness training in English could lead to cross-linguistic transfer in French in relation to the same skill.

Overall, if the present pattern of results is considered as preliminary evidence of cross-linguistic transfer, then it also suggests that the content and the teaching methods that were part of the DMSfV intervention might have provided a learning environment that fostered immediate transfer. Indeed, the potential transfer from English to French was observable in the same semester as the small-group interventions were carried out and not later on. Something about the Direct Mapping (DM) and Set-for-Variability (SfV) strategy combination seems to be at the

origin of students' superior performance in the DMSfV condition. However, within the present research design, it is not yet possible to determine if one of those two strategies alone drove this effect. Future work will need to investigate the impact of each strategy on cross-linguistic transfer independently. Nevertheless, hypotheses for tests in future studies can be developed. As mentioned by Savage, Georgiou, et al. (2017), two aspects of the DMSfV intervention were different from the ones of the two other experimental conditions. One or a combination of those aspects could have contributed to the important improvements observed in participants' performance in English and therefore, in French. One of those distinctive aspects was the teaching of word reading strategies in relation to the concept of "set-for-variability". Another one was the explicit and systematic teaching of phonics combined with shared-book reading including the taught GPCs. Each of those aspects will be discussed in connection with their possible impact on cross-linguistic transfer.

The first distinctive aspect of the DMSfV intervention was the teaching of cognitive and metacognitive word reading strategies that were linked to the concept of "set for variability" (Tunmer & Chapman, 2012). This concept refers to the phonological flexibility that might be required to read unknown words when phonological knowledge is not sufficient (Elbro & de Jong, 2017). Thus, when students were faced to a sequence of decoded GPCs that did not 'make sense' as a recognizable word in their lexicon, they were taught to try and match this sequence to a word in their mental lexicon. For example, when decoding a word like "was" as /wəs/, children were encouraged to match this unknown word or phoneme sequence (/wəs/) to a known word in their lexicon ("was"). Students were also taught to use this kind of strategy when faced with a digraph that could be mapped to more than one phoneme (e.g. "ou", "ow", etc.). Thus, when reading an unknown word such as "low", students learned to try out both possible GPCs for

"ow" (i.e. /ɪoʊ/, /ɪaʊ/) and then decide which one matched a word in their mental lexicon. As noted earlier such a strategy may also be useful for all words because even for a regular word with consistent vowel pronunciations, the result of accurate phonic decoding yielding a spelling pronunciation is not identical to a stored lexical representation (Elbro & de Jong, 2017).

In the scientific literature, metacognition in itself and thus, teaching practices oriented towards metacognition and self-regulation have been associated with learning and transfer over the years (Bransford et al., 2000; De Corte, 2003, Tardif, 1999). In his model of transfer, Tardif (1999) explicitly mentions that the efficiency of the cognitive process of transfer depends on metacognition and motivation. The influence of word reading strategies in English on the improvement of word reading in French can be considered in two different ways. A first possibility is that, as shown in previous studies (Snow, 2008), word reading strategies were directly transferred and used to read French words. Another possibility is that the teaching of word reading strategies may have improved students' self-teaching (Share, 1995). The latter has often been linked to improved performance when reading an L1 (e.g. Bowey & Muller, 2005; Cunningham, Perry, Stanovich, & Share, 2002; Nation et al., 2007) and might also have an important impact when learning to read a L2. Indeed, a student who is able to monitor his own learning by adapting his existing knowledge to properly decode a new word in L2 (i.e. transfer) will arguably improve his L2 reading skills faster than a student who does not demonstrate such a capacity to transfer. Thus, the present results could mean that the teaching of word reading strategies in L1 is amenable to cross-linguistic transfer and that it can positively influence word reading in L2. In this case, specific teaching strategies should be used in order to support this transfer more directly. Those will be discussed further in the section relative to the practical implications of the present results.

The second distinctive aspect of the DMSfV intervention was the systematic and explicit teaching of GPCs and the close link between the taught GPCs and the shared reading of books containing many words with those digraphs. Thus, in each lesson, singleton GPCs were taught to students followed by the teaching of digraphs. Thus, the possible mappings of specific digraphs were explicitly taught to students. For example, the digraph "ou" sometimes maps to /aʊ/ (e.g. "mouse"), sometimes to /ə/ (e.g. "enormous") and sometimes to /ɔ:/ (e.g. "four"). Students had time to practice through little games and then had to read words containing the target GPC during shared-book reading. Explicit and systematic teaching is known as the best method to improve word reading among at-risk students (Swanson, 1999). The close connection between the taught GPCs and the words that were encountered in shared-book reading might also have helped students to deepen and consolidate their learning of the decoding mechanisms and the taught GPCs. The fact that the books contained a high density of the taught GPCs increased the frequency of those GPCs during each lesson compared to the other conditions where GPCs in books were not controlled. Seeing each GPC more frequently might have improved learning. Since the mechanisms of word decoding (i.e. phonological recoding) are highly similar between French and English, students might have directly transferred those when reading in French. However, the majority of digraphs that were taught in English cannot directly be used to read French (i.e. "ea", "ou", "sh"). Some of those digraphs are unique to English while others exist in French but do not map to the same phoneme. Still, their teaching may have had a positive impact on French word reading. Indeed, some (e.g. Deacon et al., 2012), would argue that learning and developing precise mental representations of GPCs in English might have increased students' cognitive sensitivity to letter-sound patterns, which could then have helped them to acquire some

specific knowledge of French GPCs too. In other words, this increased sensitivity to letter-sound patterns might have led to increased self-teaching in English and in French.

Each of the distinctive aspects of the DMSfV intervention presented above might have contributed to students' improvement. Theoretically, however, it seems most plausible that it is the combination of those two aspects that led to significantly improved performance among those students. As mentioned in the literature review, the sole use of phonology and letter-sound knowledge is not enough to decode words proficiently in English and neither is the use of a "set-for-variability" strategy (Tunmer & Chapman, 2012). As suggested by word reading theories (e.g. Ehri, 1999; Seymour, 1986), the use of multiple sources of information about words (i.e. phonological, orthographical and semantic) is needed to read proficiently in an opaque orthographic system such as English. Also, the use of semantic word reading strategies such as "set-for-variability" relies heavily on students' vocabulary and phonological knowledge. Thus, within the DMSfV condition, the systematic explicit phonics instruction might have supported students' use of a "set-for-variability" strategy and vice versa. Thus, this multi-component teaching, rather than only one of the distinctive aspects of the DMSfV, might be what led to significantly better reading in English and in French among students in this condition.

Results for Grade 2. Results of the multilevel analyses regarding the impact of the Grade 2 intervention did not yield any significant results in English or in French. Regression coefficients indicate that there were no significant differences between experimental conditions at post-test, in either language. However, inspection of effect sizes rather suggests that the Simplicity intervention had a positive impact on students' performance when reading in English. Indeed, a large effect size (d = 1.52) was observed for WJ - pseudoword reading, indicating a clear advantage for the Simplicity condition. Small effect sizes were also found for the blending

task of the CTOPP as well as for the word reading task of the WRAT. Even though the impact of the small-group intervention was not significant and did not yield effect sizes as large as in Grade 1, potential evidence of close transfer to English was found and cross-linguistic transfer to French could be explored. Analysis of the French outcomes revealed a small effect size of 0.26 for irregular word reading favoring the Simplicity intervention. No other effects were clearly evident in French. This finding is arguably in line with the small effect size found for the WRAT in English. This pattern of results might be considered as consistent with the presence of cross-linguistic transfer. However, since a large effect size was found for pseudoword reading in English, a certain effect for the same ability in French would have been expected too, especially since the Simplicity small-group intervention focused on the teaching of orthographic patterns and advanced phonics, which is related to pseudoword reading. Nonetheless, it was not the case. Since most of the orthographic patterns that were taught were patterns rather specific to English (e.g. igh, ed, etc), it might have been more difficult for students to transfer their new knowledge in French.

What can perhaps be concluded is that the intervention was either not long enough or that the teaching methods that were used were not sufficient to support cross-linguistic transfer. Another hypothesis that could explain the absence of effects following the Grade 2 small-group instruction is the content of the intervention itself. Indeed, in Grade 2, the intervention focused on the explicit teaching of the most frequent grapheme-phoneme correspondences that were not mastered by students. Thus, similarly to Grade 1, the focus was on the teaching of grapheme-phoneme correspondences. Working on grapheme-phoneme relationships might not have been sufficient to support at-risk students in Grade 2; maybe an intervention on another aspect of reading would have addressed their difficulties in a more appropriate way. Still, Chen and

Savage (2014) reported the very positive impacts of this same intervention among struggling Grade 2 students. This suggests that the intervention focussing on grapheme-phoneme relationships can be helpful for Grade 2 students. That being said, the small effect size on irregular word reading in French might cautiously be considered as preliminary evidence of cross-linguistic transfer. However, this effect is rather small and concerns an outcome for which no considerable effect size was found in English; its relevance as a measure of transfer is thus questionable. Also, even though the ELLCO was effective to control overall teaching quality between experimental conditions, specific teaching contents that could have benefited the Simplicity group might not have been detected by this tool.

Research question 2: The second research question was the following: what exactly is transferred between English and French? Is transfer happening at the level of specific knowledge (e.g. specific GPC) or at the more general level of process (i.e., letter-sound rules generalization), or both at the level of specific GPCs and letter-sound rules generalization?

Since evidence of cross-linguistic transfer to French on nonwords was only found in Grade 1, only those results were used to seek an answer to the second research question. Performance on nonwords rather than on real words was also explored to answer question 2 since they could only be read through phonological recoding. Students could not try to guess what the words were or read them as sight words. Nonwords were thus the best type of word to evaluate students' decoding process. Errors at midtest and at post-test were coded either as errors due to phonological skills (i.e. decoding process) or to GPC knowledge (i.e. specific knowledge). In addition to determining what might be transferred across languages, this type of analysis also relates to Ehri's model (1999) and gives insight of the qualitative changes in students' reading following the intervention.

The results of multilevel analyses as well as inspection of effect sizes suggested that experimental groups differed in terms of the proportion of phonological errors made at post-test. Here, both the DMSfV and the CBP groups made fewer phonological errors at post-test than the control group. This could be interpreted as the impact of teaching the mechanics of phonological recoding, which was done in both interventions. As mentioned earlier, since the decoding mechanisms are the same in English and in French, once learned in one language, they are, it could be argued, generalizable. Thus, they might have transferred and helped decrease the proportion of errors due to that aspect of reading in both languages. On the other hand, proportion of errors due to GPC knowledge at post-test was similar in the three conditions. However, the research design does not allow the conduct of an analysis concerning the proportion of phonological and GPC errors on English pseudowords. Thus, the absence of any significant effect of the intervention on the proportion of GPC errors in French might be due to the fact that the small-group interventions did not have a significant impact on GPC knowledge in English, precluding any possible transfer. Conversely, it might be that the interventions did have an impact on English GPC knowledge but that cross-linguistic transfer did not take place. Indeed, since only some GPCs, especially the consonants, are shared between English and French, GPC knowledge might be considered as only partly generalizable. Thus, explicit teaching of GPCs might be necessary in both languages, especially for GPCs that are not shared between languages, that is mainly vowels. It seems logical that the empirical results show the presence of transfer in the type of knowledge that can theoretically be more easily applied, without constraints, between English and French. In sum, results suggest that general decoding mechanisms (phonological skills) might be more likely or easily transferred between languages than specific knowledge relative to one language (GPC knowledge). The present results,

however, ought to be considered with caution. Even though research was conducted according to common and best practices, results can only be interpreted in light of the interventions that were run in this study and cannot be generalized to other educational contexts. The present results thus represent a first and modest attempt at answering the question "what transfers" between languages. Further experimental intervention research will be needed to explore this matter.

Conclusion. In conclusion, even though the results in Grade 1 and 2 are different, the consistency between the results in English and in French is positive in the sense that it provides evidence that the various word-level reading skills in both languages are related and seem to progress in parallel in simultaneous dual language instructional contexts. In sum, the present research aimed to determine the impacts of a supplemental intervention in English on the cross-linguistic transfer of decoding and spelling skills in French of Grade 1 and Grade 2 bilingual (English/French) at-risk students. The general pattern of results in Grade 1, showing an improvement in students' performance in French immediately following the supplemental intervention, is generally consistent with the existence of cross-linguistic transfer of aspects of these abilities. In Grade 2, the multilevel analysis of data led to more conservative conclusions regarding transfer between English and French. The Simplicity intervention led to close transfer and improvement in pseudoword reading in English. However, cross-linguistic transfer to French was not observed. The second research questions aimed to investigate what type of knowledge was most subject to transfer between languages. Results of the error analysis suggest that transfer might be occurring more at the more general level of process (i.e. a decoding mechanism) than at the specific GPC knowledge level. The next section will explore the implications of those patterns of results in terms of theories of reading and transfer.

Theoretical Implications of the Current Findings

Overall, it can be argued that the present findings, by showing preliminary evidence of cross-linguistic transfer, provide support for Cummins's (1979) developmental interdependence hypothesis (DIH), which suggests that there is a set of non language-specific capacities that supports language development across multiple languages and thus, that transfer is possible. According to Cummins, once developed in one language, these capacities or this common underlying proficiency (CUP) support the development of academic language, including literacy, in another language. Several correlational studies' results provided support for the DIH by demonstrating that reading skills in a first language were related to those in a second language (Bialystok, Luk, et al., 2005; Chiappe & Siegel, 1999; Comeau et al., 1999; Cummins, 2005; Deacon et al., 2013; Genesee et al., 2008; Kruk & Reynolds, 2012; Snow, 2008). Nevertheless, the present study is the first matched intervention study supporting the DIH. Indeed, the fact that, in Grade 1, students in the DMSfV condition performed significantly better in some English outcomes than the students in the two other conditions suggest that the small-group intervention had a measurable impact on students' reading and spelling skills in L1. The results show that the same students' performance on similar tasks was also better in French, without additional instruction beyond regular French teaching of reading to which all three groups were exposed. This finding strongly suggests that the small-group intervention in L1 also had a positive influence on L2. Hence, those results being drawn from a matched control study with pre- and post-test, the improvement in French can optimistically be attributed to the small-group DMSfV intervention, therefore providing preliminary evidence of cross-linguistic transfer. Thus, it seems that, as suggested by Cummins's, the small-group sessions led to the development of non language-specific capacities that supported language development in both languages.

The nature of those non language-specific capacities still remains to be determined. In light of the present results, phonological awareness (metalinguistic abilities) and word reading strategies (metacognition) could, however, be suggested as potential candidates. Indeed, theoretically, both abilities are necessary to adequately read in alphabetical orthographies. In addition, these abilities can be used in a similar way in English and in French by making only small adaptations. Indeed, the "set-for-variability" strategy and the decoding mechanisms can be used in the same way in both languages. In a sense, they can thus almost be directly transferred from one language to another. The only important difference between English and French that requires adaptation is GPC knowledge. Empirically, research has shown the important link existing between phonological awareness in L1 and L2 and authors have already identified the latter as a potential non language-specific ability (Bialystok, McBride-Chang, et al., 2005; Comeau et al., 1999). The present results are consistent with this general view. Indeed, results suggest that, following systematic phonics instruction, improved performance in phonological awareness can be observed in English and French in Grade 1, which could arguably be linked to cross-linguistic transfer. Moreover, results suggest that transfer happened more easily at the general level of process (i.e. metalinguistic abilities) than at the level of specific knowledge (i.e. specific GPC). Thus, empirical evidence supports the theoretical claim suggesting that metalinguistic abilities are language general abilities.

As metacognition is concerned, past research has suggested that reading strategies in L1 are linked to those in L2 (Lallier et al., 2016; Snow, 2008). For example, Lallier et al. (2016) compared the word reading and visual attention span skills of Spanish-Basque and French-Basque bilinguals Grade 2 students. Their results suggest that the orthographic properties (i.e. opacity) of an L2 influence the word reading strategies used in L1. Thus, children learning to

read an opaque L2 (i.e. French) developed larger grain size word reading strategies and relied on larger orthographic units (e.g. consonant clusters) when decoding words in both languages. On the contrary, children learning two transparent orthographies relied on small grain strategies. Thus, the results of Lallier et al. (2016) suggest that Grade 2 students transferred word reading strategies between languages. In a similar way, in the present study, the superior performance of the DMSfV group in multiple reading outcomes in Grade 1 also suggest that the teaching of word reading strategies, a unique feature of the DMSfV intervention, might have transferred and supported word reading in both languages. Evidence from prior studies and present research therefore suggests that metacognitive skills may also be non language-specific abilities. In order to confirm those hypothesis, future empirical research will need to explore the influence of those two abilities in L1 and in L2 and determine if: 1) they are language specific or language general abilities, 2) they can causally be considered responsible for cross-linguistic transfer. To do so, experimental intervention research will need to explore the impact of proven effective teaching practices for those abilities in L1 on cross-linguistic transfer. By implementing effective practices in one language only and measuring students' progress in both L1 and L2, it would be possible to determine if cross-linguistic transfer of those abilities is at all possible and if they facilitate cross-linguistic transfer of other word reading abilities.

Results of the present research can also be interpreted in light of existing developmental reading theories. As mentioned in the literature review, to date, no developmental model of reading acquisition for bilingual children exists in the scientific literature (Sauval, Perre, Duncan, Marinus & Casalis, 2017). Thus, as is generally the case in research articles regarding biliterate students' development, the present results will first be positioned within developmental models of monolingual reading acquisition. Moreover, the present study was conducted with beginning

readers in Grade 1 and 2, it thus seems more appropriate to interpret the results through a developmental model, rather than through models of skilled reading such as the dual route cascaded model (Coltheart et al. 2001) or the triangle model (Seidenberg & McClelland, 1989). Potential implications of the present results for the development of bilingual word reading models will be discussed.

Each of the many developmental models that can be found in the literature (Ehri, 1999, Grainger, Lété, Bertand, Dufau, & Ziegler, 2012; Seymour, 1986, 2007, 2008) makes two main assumptions about early literacy development in alphabetical writing systems: 1) they assume that metalinguistic abilities are the foundation of reading development and 2) they suggest that a procedure of phonological recoding of words is gradually replaced by faster and automated recognition of words. The present results showed that Grade 1 students part of the DMSfV condition improved significantly more than the other students in phoneme blending and word reading in English and in French. Thus, even though the intervention was conducted only in English, results suggest that those students' reading development progressed in a similar way in both languages: students improved their metalinguistic abilities and their phonological recoding in both L1 and L2.

Those results have potential implications for the development of bilingual word reading models. Overall, they suggest that reading development in L2 is not independent from the one in L1. Future models of bilingual word reading should test this idea of non-independence, especially regarding early development. Evidence from the present study also seems to suggest that, as indicated in L1 models (Ehri, 1999; Seymour et al. 2003), metalinguistic abilities and phonological recoding are at the center of early bilingual reading development, at least in the case of English and French. Clearly, bilingual word reading models should also be able to

explain how the development of reading processes in a first language influences the development of the same processes in a second language and vice versa. The present data allow the formulation of hypotheses that will need to be put to test in future research. Some of these are considered below.

Two mechanisms of cross-linguistic transfer that could explain the influence of L1 on L2 will be explored here. Firstly, it seems logical to think that one of the paths to transfer is the direct use of L1 knowledge/process when reading L2. Indeed, if components of L1 reading, be it knowledge or process, are identical to those needed to read in L2, they could directly be transferred and used to read in L2. For example, GPCs that are identical in English and in French (i.e. “b”, “m”) may be directly transferred, without any adaptation. The same thing could be said about metalinguistic abilities. Thus, knowledge and cognitive processes that are non language-specific may transfer more easily, therefore facilitating reading development in L2. Therefore, this view predicts generalization errors in L2 conceptually and maybe empirically akin to regularization errors in L1 opaque systems. Secondly, there could also be an indirect route to cross-linguistic transfer, where, as Cummins (1979) argues, an underlying general ability supports transfer and reading development. When components of L1 reading, whether knowledge or processes, are different than those needed to read in L2, they need to be adapted to be adequately transferred and used. The hypothesis that will be put forward here is that alongside appropriate exposure and instruction in L2, metacognitive abilities could well be one of the underlying abilities necessary for this adaptation. Indeed, adequately adapting knowledge from L1 to L2 logically requires reflection upon and conscious manipulation of one’s knowledge. Thus, the teaching of word reading strategies that can be used in both languages, such as the concept of set-for-variability, might support transfer, despite the imperfect overlap of specific

GPCs between languages. For example, when decoding an unknown word (i.e. peur) with an unknown GPC in French (i.e. p**eu**r), a student could try to match the decoded GPC chain (i.e. pe-ur) to a known word in the lexicon. From this success, a process of self-teaching could lead the student to learn that "eur" in French makes the sound /œʁ/ as well as improving the process of graphemic parsing, thus leading to L2 reading development. If such a self-teaching process does not take place, then, the reading components that are different between L1 and L2 would need to be taught and learned one at a time. A very similar idea was advanced by Savage and Stuart (2006) about young students' reading in L1.

Considering the present results, another hypothesis could be formulated concerning reading development in bilingual children. Many models of L1 reading assume that what drives development is the qualitative change in one's cognitive representation about language as applied to reading (e.g. Duncan, Colé, Seymour, & Magnan, 2006; Ehri, 1999; Gombert, 2003). Bialystok's (1978) model of second language learning is also based on this idea. Thus, development is thought to be based on the gradual transformation of implicit knowledge into its more explicit form, that is then more consciously accessible. This process of transformation is at the heart of Ehri's L1 theory which models the qualitative changes in students' word reading across development. Such transformation is thought to be driven by environmental demands and pressures. The need to discriminate between an increasing number of written words, for example, would force the cognitive system to develop more precise representations of linguistics units. Therefore, it could be hypothesized that having to master two related but distinct writing systems at once may increase the pressure on the cognitive system and thereby create the need for the development of more precise or explicit representations of the different linguistic units and/or speed up this development. Theoretically, evidence of this hypothesis would be the presence of

greater metalinguistic awareness among biliterate students when compared to monolingual matched controls students. As presented previously, some studies in the literature have already demonstrated this bilingual facilitation phenomenon (e.g. Genesee & Jared, 2008; Kruk & Reynolds, 2012). Another implication of that hypothesis would be the greater generalization resulting from those more precise representations. Indeed, in L1, the development of more precise representations is associated with improved access to knowledge and greater cognitive flexibility in the use of that knowledge. Thus, in a bilingual context, this cognitive flexibility could well be associated with cross-linguistic transfer. Indeed, the latter could well be the cognitive systems' way to answer to the greater pressure of a bilingual environment: Forming more explicit representations in L1 might trigger the development of more precise representations in L2 as well. Future research should explore this conceptual hypothesis, which predicts that in intervention studies, more explicit representations of phonological and reading skills would be evident in comparison to controls. A detailed analysis of the qualitative changes in students' reading, as predicted from Ehri's L1 model, in comparison to controls could also be informative about bilingual students' cognitive representations across development as well as cross-linguistic transfer. The present research, by analyzing students reading errors, gives a small insight of the qualitative changes in bilingual students' reading in L2 after an intervention in L1. However, a more controlled intervention and a more detailed analysis of qualitative changes should be undertaken in future work.

Lastly, the observed transfer between English and French in Grade 1 is also an indication that, as suggested by Deacon et al. (2009), English and French are sufficiently similar to give rise to transfer. Considering the present results, they seem sufficiently similar for transfer to occur across multiple literacy skills (e.g. regular and irregular word reading, phonological awareness)

and even among at-risk students. Snow (2008) argues that similarities between the written forms of two languages seem to increase the likelihood of transfer, even if those two languages have less transparent orthographies like English and French. Since the present research is only consistent with transfer between two languages, it is impossible to draw conclusions related to cross-linguistic transfer in other languages. It is only possible to say that transfer seems possible between similar languages, such as English and French. Future studies will however need to investigate that issue.

Limitations

The present study is subjected to various limitations that need to be considered when interpreting the results. These will be discussed in next section below.

Study sample. This study involved a total of 22 classes and 99 at-risk students in Grade 1 and 17 classes and 52 at-risk students in Grade 2. The minimum sample size that is required to perform multilevel analyses has been the subject of much discussion in the literature. One of the common conclusions is that the number of level-2 units is of more importance than the number of nested level-1 units (Maas & Hox, 2005). The number of 30 level-2 units is usually cited as being considered adequate to perform unbiased HLM analyses, regardless of the number of level-1 units in each cluster (Kreft, 1996; Maas & Hox, 2004). However, Maas and Hox (2004) mentioned that when only interested in the fixed effects coefficients, as is the case in this study, smaller groups can lead to adequate estimates. The present study, with a sample of 22 classrooms in Grade 1 and 17 classrooms in Grade 2, has smaller samples than would have been desirable for a multilevel analysis, especially in Grade 2. However, generally speaking, small samples lead to underpowered studies, which usually increase the likelihood of a type II error (i.e. incorrectly retaining a false null hypothesis). Thus, underpowered studies can be considered as more

conservative: Only larger effects will come out as significant whereas smaller one will not. Hence, the fact that significant differences were found between groups alongside moderate effect sizes following the Grade 1 intervention relative to word reading, even with a smaller sample, suggest that the study was sufficiently powered to detect such effects and that these are substantial. In Grade 2, however, the absence of significant effects might be due to the small sample and thus, a lack of statistical power. To counteract the possibility of type II errors, effect sizes were therefore also considered in the interpretation of the results. Replication of the present study with a larger sample is still needed in order to draw a more complete picture of the impact of an intervention on cross-linguistic transfer. The multi-province study in which this research is embedded does include a larger sample of biliterate students. However, for logistic reasons, and within the scope of the limited time and funding inherent to this doctoral work, it was not possible to collect data in the other province. Including biliterate students from a province different of Quebec would also have introduced a confound relative to the different ambient levels of French in a province such as Alberta.

Random assignment. In experimental research, randomized controlled trials are considered to be one of the highest quality designs to investigate the presence of a causal relationship between variables. Random assignment of participants to experimental groups is also considered as the optimal method for assigning participants to study conditions since it increases the probability of obtaining equivalent groups (Gersten et al., 2005). The larger multi-province quasi-experimental study in which the present study was embedded randomly assigned schools rather than individual students to one of the experimental conditions. This decision was necessary in order to avoid confounds that would be related to any sharing of information between the students in two different experimental conditions in the same school over several

years of sustained intervention. However, even if school was considered as a viable option as the unit of random assignment (Gersten et al., 2005), it still affects the interpretation of the results as not enough schools were included in the multi-year project to allow for HLM analyses at the school level. Thus, the analyses were undertaken at the classroom and student levels. The use of multilevel analyses allowed to control for classroom and participant variation, but not for school level variation. Nonetheless, the effect of extraneous variables such as teaching quality and mother education were explored in order to make sure they did not have a significant effect on the results of the HLM analysis.

Control over groups. Originally, in the larger pan-Canadian study, the goal was to set up two experimental conditions with small group interventions relative to reading that could be compared to a control condition with a small group intervention relative to socio-emotional skills. However, some of the schools did not agree that researchers run such a program during curricular time. In-class support from the RAs during English language art periods was therefore a pragmatic response to teachers' requests. This situation shows that implementing a "perfect" control condition that is in line with schools' needs is one of the real issues met when running field base studies with school partners. Thus, the CSF control group intervention was mainly composed of the RAs in-class support during English literacy instruction, but their intervention was not planned or organized in any specific way but was designed to respond to teacher-perceived day-to-day needs in the classroom. The fact that the intervention was, in the end, broadly related to literacy in providing students with general academic support does not make it a "perfect" control in a methodological sense.

Reliability of measures. The inclusion of high quality, valid and reliable measures to evaluate the impact of an intervention is a key quality of any experimental research. Thus, the

use of standardized tests is often recommended since they usually have high validity and reliability levels. Such measures, albeit their effectiveness is sometimes criticized, are easily accessible for English language. However, standardized tests in French are still few in number (Cormier, Desrochers, & Sénécal, 2006) and even less so for Canadian/Quebec French. Thus, in the present research, the choice was made to use measures that were designed to evaluate Quebec students' French reading and that were in the process of being normalized. Unfortunately, at the time of data analysis, the development of standard scores for those measures was still ongoing. Norms were not yet available and thus, could not be used. However, since they were normalized with students attending French elementary schools, the norms might not have represented bilingual (English/French) students' performance adequately. Those "Quebec designed" measures were part of Professor Alain Desrochers' "ECOLE" battery. The "ECOLE" irregular words list, the regular word lists and the phonological blending task were used within the present study. Even though this battery is relatively new, high correlations ($r > .8$) were observed between students' performance on "ECOLE" measures and similar measures widely used in the field (e.g. BELEC), indicating high concurrent validity. The "ECOLE" measures can also be considered highly reliable since the Cronbach's alphas for each test is superior to .88. The Spearman-Brown split half correlation superior to .90 for each test also indicate their reliability. Therefore, the even though norms could not be used, it can be concluded that the "ECOLE" tests that were used are reliable and valid measures.

Notwithstanding this, the content validity of some of the exception words can be debated. To be included in the list, to be included in the list, items needed to present at least one inconsistent GPC in French. Orthographic consistency refers to the extent to which a grapheme consistently maps onto the same phoneme and vice versa. Consistency can reasonably be

represented as a continuum rather than as a dichotomous concept. The first items on the irregular word measure of the "ECOLE" contains GPCs that are considered inconsistent according to the work of Sprenger-Charolles et al. (2005). However, others could consider those items as regular-consistent, since their inconsistency is not as obvious as for the other items in the list. For example, the second item of the list is "famille" (i.e. family) and the GPC "ille" that maps onto the sound /i j/ is considered to be the inconsistent one, even though this mapping is somewhat common in French. In other items in the list, such as "pied" (i.e. foot"), the inconsistent GPC is more obvious as "ied" mapping onto /j e/ is an exception in French orthography. Grade 1 students in the present study read an average of 2.16 irregular words at post-test. The interpretation of this result in relation to students' capacity to read irregular words thus needs to be done by keeping in mind that the first items of the test may be considered as somewhat less inconsistent.

The nonword list and the grapheme to phoneme conversion task were experimental measures designed for the research. Some standardized measures of these two constructs are available in French, but were either standardized in France (and are thus not representative of Quebec children) or were not suited for the present study. The experimental nonword list was also designed to include specific GPCs in order to investigate transfer. Even though the GPCs in the experimental nonword list were controlled at best, other linguistic aspects such as word length or grapheme complexity were not explicitly controlled. Some would argue that the use of unstandardized measures is associated with inflated effect sizes (Gersten et al., 2005) and thus, might lead to an overestimation of effect sizes. However, statistical analyses revealed that significant effects in French mirrored the ones found in English and also that effect sizes were of similar magnitude in both languages. Thus, because results in English were obtained on the basis

of standardized tests, they might be considered as reinforcing the validity of the results obtained in French. The reliability coefficient of the nonword list (r = .93), the spelling measure (r = .83) and of the grapheme to phoneme conversion task (r = 0.88) also reflect those measures' consistency.

There are also limits relative to the error pattern analyses done in relation with the nonword list. First, inter-rater coding of errors would have been necessary to ensure the reliability of coding. However, due to resource constraints in the scope of this doctoral work, it was not possible. Second, to be able to attribute the significant difference between groups in the proportion of error to cross-linguistic transfer, it would have been necessary to evaluate the same patterns in English, which was not possible. Indeed, errors on pseudoword reading in English were not recorded during the test. Thus, the improvement shown in reading nonwords in French could be due to cross-linguistic transfer, but could also be attributed to other factors that could not be taken into account in our analyses. For example, even though the ELLCO controls for general teaching quality, specific aspects of teaching such as the precise nature of the taught GPCs in class or the order in which GPCs were presented to students could not be measured or controlled for by this observational tool. The ELLCO was also not designed to evaluate dual-language teaching. Still, the fact that improvement in favor of the DMSfV condition was observed in both languages suggests that the small-group intervention in English contributed to the observed improvement in French.

Effective intervention components. Lastly, as mentioned by Savage, Georgiou, et al. (2017), many aspects differed between the three experimental conditions (DMSfV, CBP and CSF). Within the present research design, it was not possible to determine if and which components of the DMSfV intervention led to improved performance in English-reading skills.

Thus, the same applies for cross-linguistic transfer. It is not possible to determine if one or a combination of the distinct aspects of the DMSfV intervention has further supported cross-linguistic transfer. Future work is needed to experimentally titrate intervention content to establish whether one of those pedagogical aspects alone has a specific impact on learning and cross-linguistic transfer.

In the same line of thinking, to better understand the impact of the experimental conditions on students' reading, an experimental measure of English and French "set-for-variability" would have been necessary. Indeed, a task similar to the one used by Tunmer and Chapman (1998) in which children are asked to find the correct pronunciation of mispronounced spoken words would have helped to better understand students' word reading skills. It also could have helped to determine if the teaching of a "set-for-variability" strategy led to significantly different performance in English and in French among students of the different conditions.

Students' characteristics. Some factors that could have played a role in cross-linguistic transfer could not be considered within the present analyses. Indeed, transfer is also likely attributable to students' characteristics such as age of exposure to L2 or perceived relevance of learning an L2 (Cummins, 1979). The impact of these characteristics on cross-linguistic transfer cannot be investigated within the present research design. Indeed, since experimental groups were not formed on the basis of those characteristics, it is not possible to determine which individual characteristic led to increased transfer or not.

Implications for Practice and Policies

The previous section of this thesis aimed to interpret the results of the present study in light of theoretical models and previous empirical results. Even though certain limits ought to be

considered, this study provided potentially relevant information concerning reading development and cross-linguistic transfer in a biliterate educational context, which have many potential implications, both at the practical and policy levels. These are thus discussed here.

The main practical implication of the present research concerns teaching practices in relation to cross-linguistic transfer. Indeed, the pattern of results that is consistent with cross-linguistic transfer suggests that, when learning to read two quite similar languages, it is not necessary to learn everything in both languages but that it is possible to take advantage of knowledge in L1 (i.e. the language best mastered by students) to build knowledge in L2. Moreover, the results suggest that this might be possible, even for at-risk students. Hence, if transfer is possible, it is indispensable to tailor our teaching methods in order to promote the development of optimal learning environments that will in turn favor transfer. If teaching and learning are more efficient, then valuable instructional time can be spared and used for other purposes, which could help, among other goals, to prevent the development of reading difficulties.

Both the scientific literature and the results of the present research provide answers regarding the best teaching practices to promote cross-linguistic transfer. Previous research has demonstrated that, among these methods, the use of explicit teaching (Bialystok, McBride-Chang, et al., 2005; Lesaux & Siegel, 2003) and small-group interventions (Kamps & al., 2007) are the ones that stand out as the most predictive of success. The results of the present study are consistent with that view. They suggest that, in early grades, explicit and systematic phonics instruction including the teaching of simple graphemes, digraphs, English reading rules (e.g. final “e” rule), set-for-variability and the principles of blending phonemes together constitute practices that can support cross-linguistic transfer to French. Such practices should therefore be

adopted in the context of Grade 1 teaching in French Immersion programs. However, results also seem to suggest that even though transfer is possible, some literacy skills in L1 are less subject to transfer to L2. Indeed, the results indicate that phonological recoding mechanisms might transfer more easily than specific GPC knowledge. Therefore, it may be necessary for teachers to explicitly teach GPCs in English and in French and to highlight similarities and differences between each language. Focusing teaching time on the skills that are less subject to transfer would better support reading development in both languages. Moreover, explicitly highlighting similarities and differences would certainly help students to develop more precise representations of each language's characteristics, which would in turn support reading development in both languages. Of course, this applies only to immersion programs where children learn both languages at the same time. In programs where children learn to read English only in Grade 3, teaching strategies in the early grades need to be focussed on the effective teaching of the L2 rather than on cross-linguistic transfer. Still, certain aspects of L1, such as cognates, can still be used to develop L2 knowledge.

Furthermore, the superior performance observed among the DMSfV students also suggests that the teaching of metacognitive strategies had a positive impact on cross-linguistic transfer. Also, as mentioned before, metacognition has been associated to increase reading performance in L1 (Pressley & Afflerbach, 1995; Schmitt, 2005; Smith, Borkowski, & Whitman, 2008) and in L2 (Tardif, 1999). Thus, the explicit teaching of word reading strategies in early grades should be integrated to the curriculum of immersion programs, since it is not currently the case. Thus, to support students' reading development, teachers should explicitly teach reading strategies in line with the concept of set-for-variability (i.e. matching a decoded GPC sequence to a word in mental lexicon) as early as in Grade 1. Those strategies could be used by students both

in English and French and could help them read new words in both languages, despite differences between writing systems. In the same vein, it may be useful for teachers to explicitly demonstrate how those strategies can be used in both languages, in order to support students' learning and generalization.

Another implication of the present results concerns the adequacy of immersion programs for at-risk students. Indeed, it has been advocated before that bilingual and immersion programs were not detrimental for students experiencing difficulties (Bruck, 1985; Da Fontoura & Siegel, 1995; Francis et al., 2006; Kruk & Reynolds, 2012; Snow, 2008) and even that bilingual facilitation was observed among those students (Adesope, Lavin, Thompson & Ungerleider, 2010; Genesee, 2004; Lesaux et al., 2006; Lesaux & Siegel, 2003; Lesaux et al., 2007; Slavin & Cheung, 2005; Verhoeven, 2000). The present matched intervention study adds to this literature by providing preliminary evidence that progress relative to decoding skills in L1 can lead to improvement in the same area in L2, without additional instruction in that language, even for students that were identified as being "at-risk" in English word reading. Therefore, it suggests that bilingual (English/French) or immersion programs can be appropriate for young at-risk children. Rather, policies concerning "at-risk" students in immersion programs should be geared towards the implementation of practices that aim to increase performance in English (generally L1) and support transfer to French (generally L2).

Another potential implication can be derived from the present results. The preliminary evidence of transfer obtained through this research seem to indicate that early concurrent exposure to both languages can have a positive influence on reading development. Indeed, as hypothesized in a precedent section, the need to learn two languages at the same time might support the development of more explicit and precise cognitive representations, leading to cross-

linguistic transfer. If this hypothesis is true, then, early exposure to the teaching of reading in more than one language could be considered as another form of bilingual advantage. Therefore, the present results might be indicating that policies need to be oriented towards the support of early rather than late exposure to multiple languages. Moreover, as mentioned earlier, for this early exposure to be most effective, teaching in both languages should be geared towards transfer. This means, among other things to coordinate teaching between L1 and L2 and to explicitly highlight similarities and differences between languages, which is not addressed by current policies. Indeed, as Cummins (2014) mentioned, even though all provinces support dual-language instruction, bilingual programs and policies are not designed to encourage teaching that would support transfer across languages and that would promote both languages equally. More specifically, Cummins refers to what he calls the "two solitudes assumption"; within the actual programs, dual-language instruction is accomplished by exposing students to two independent monolingual instructional contexts, rather than one instructional context where constant links would be made between languages. Therefore, an educational context where the teaching of both languages (majority and minority language) is interlaced and interconnected might be a more effective way to promote reading development as well as cross-linguistic transfer within immersion programs. Programs should therefore be organized to take advantage of the similarities between languages under study and to overcome the difficulties that might be caused by the differences between them (e.g. specific GPCs of each language). Based on the results of the present study, reliance on the language students decode best might be the most effective way to highlight similarities and differences between languages, since students have more developed representations of this language. Educational policies should also concern ways of communicating knowledge and providing professional development to teachers in order to

support them in the adoption and integration of best practices in dual language educational contexts (Savage & Côté, In press). For example, teachers should be encouraged to collaborate and plan similar and coherent lessons in English and in French. The concept of majority/minority language should also be taken into account when developing policies. Indeed, policies should try to support both taught languages equally and not favor one over another.

Implications and Directions for Future Research

To our knowledge, only two other intervention studies concerning cross-linguistic transfer between L1 and L2 can be found in the literature. However, they both concern phonological awareness skills. The present study is thus the first matched control intervention research related to word reading skills to provide a pattern of results that can arguably be associated with transfer. The information that can be drawn from the results, however, represents only the first steps towards an understanding of the mechanisms of transfer of learning between languages. Much work is still needed to provide a more specific description of the cognitive mechanisms underlining transfer as well as information about the best teaching practices to foster learning and cross-linguistic transfer in dual-language educational contexts. Other research will be necessary to address the multiple questions pertaining biliteracy and transfer of learning in bilingual educational contexts. The issues that will need to be explored more specifically in future research are discussed below.

First, considering the previously presented results, future studies need to replicate the present one to provide more precise answers to the questions it raised concerning cross-linguistic transfer. Thus, in order to explore the impacts of a given intervention and to gather stronger evidence of the presence of cross-linguistic transfer, those replications should include, among others, randomized controlled trials (RCT) with delayed post-tests. Such research designs could

provide a better control on extraneous variables and would allow verification of the long-term impacts of the intervention. The impact of an L1 on a L2 needs to be further studied, but the impact of an L2 on an L1 also requires more attention. Future studies with bigger samples are also needed to allow for more powerful statistical analyses. Still in the domain of methodology, a better control over the different groups in the study is needed in the future, especially the control group. Indeed, participants in the different groups should be comparable on extraneous variables (e.g. teaching practices, SES, mother tongue) and the intervention to which they are exposed should be carefully designed and delivered. Lastly, it would also be advantageous to replicate the present research in other educational contexts or systems, for example in other Canadian provinces. Indeed, it would be very informative to observe the impact of the intervention in English on French reading in provinces with different ambient levels of French or with different immersion programs. Such a study would allow researchers to determine at what point the present results can be generalized to other educational contexts. It will also be necessary to conduct similar studies in educational contexts with different L1 and L2.

Future research will also need to use research designs that will allow to isolate different teaching components to determine which ones have the most impact on students' transfer. Indeed, the results of the present study, as well as other research (August & Shanahan, 2006; Gersten & Geva, 2003; Kamps & al., 2007; Schwartz et al., 2012; Snow, 2008) demonstrate that explicit teaching is more effective than other methods to promote transfer. More research, however, is needed to identify the most efficient teaching components. Future experimental research needs to, for example, compare cross-linguistic transfer of students in three different conditions; one in which participants are explicitly taught how to use word reading strategies (i.e. set-for-variability), another one in which they receive explicit and systematic phonics instruction

and a last one in which students are exposed to both phonics and word reading strategies. It will also be essential to conduct experimental studies exploring the cross-linguistic transfer of various reading and writing skills that could not be explored in the present research (i.e. morphology, syntax, reading comprehension strategies) and that, from L1 to L2 and vice versa. Indeed, such studies are needed to determine if those reading/writing abilities are also subject to transfer and to determine which teaching methods can effectively support transfer.

Other experimental studies are also needed to investigate how diverse educational factors influence transfer. It would be impossible to name all those factors here, but studies will need to explore how cross-linguistic transfer varies depending on, among other factors, the nature of L1 and L2 being taught, students' mother tongue, and motivation. Additionally, in contexts like Canada where children enrolled in French Immersion programs receive instruction in two languages, more attention should be given to the impact of L2 teaching practices on cross-linguistic transfer in L1.

Future research will also need to gather more specific information concerning the cognitive mechanisms underlying transfer, that is to say "how" transfer happens. Thus, as suggested above, future research should investigate the qualitative changes in students' error patterns in L2 and analyse these in relation to L1 knowledge. Research concerning the metalinguistic precision of representations in L1 and L2 after an intervention would also allow researchers to make hypotheses about the cognitive mechanisms that drive transfer. Such knowledge would support the development of appropriate theories of second-language reading development (Sauval et al., 2017), which could in turn inform teaching practices and policies. As mentioned earlier, the results of the present study arguably support Cummins's (1979) hypothesis suggesting that non language-specific capacities support language development in

multiple languages. However, in order to be able to adequately test Cummins's hypothesis at the empirical level, future research will first need to clarify the concept of "common underlying proficiency" (Koda, 2012a). Those cognitive processes supporting transfer might be language related or associated with more general cognitive abilities (e.g. analogy). Empirical studies will then need to identify the causal links between those cognitive capacities and the cross-linguistic transfer of reading abilities (Savage & Côté, In press). For example, since it is generally considered as non language-specific, further intervention research should investigate if causal links exist between the improvement of phonological awareness in one language and word reading skills in L1 and L2. Lallier et al. (2016) showed that the orthographic properties of a L2 influenced the development of phonological awareness skills and that bilingual students learning an opaque L2 had a greater sensitivity to large (i.e. syllables) phonological units. Nonetheless, future studies need to investigate how the development of phonological awareness skills in a language directly impacts word reading development in that same language as well as in an L2.

In order to refine our understanding of the mechanisms supporting cross-linguistic transfer, future research will also need to provide more precise information regarding the type of knowledge that is more easily transferred between languages. For example, researchers should consider using measures that carefully control for specific word characteristics such as frequency, regularity and type of GPC (simple, complex) in both languages in order to be able to compare performance. Such studies would support the formulation of hypotheses about the reading and spelling skills most likely to be transferred between languages.

Lastly, the development and the use of a variety of research methodologies will also be needed to gather the many questions pertaining to cross-linguistic transfer. First, qualitative analyses of biliterate students' reading and spelling productions should be considered. The

interpretation of such analyses could support the construction of theories in that domain since none are available in the literature yet (Sauval et al., 2017). The development and the use of qualitative and quantitative measures designed and normalized for bilingual students would also help to collect more precise data among those students. Single-subject experimental designs should also be considered to explore biliterate development in greater depth. Those designs usually require precise control of participants' characteristics (e.g. SES, language and reading development level, etc.), which results in more homogenous samples. This homogeneity in participants' characteristics could arguably allow a more detailed exploration of the reading skills and development of students with those specific characteristics (Horner, Carr, Halle, Mcgee, Odom & Wolery; 2005). For example, it would be possible to include in a study only students at a certain reading level, who were exposed to the same L1 and L2 and at the same age. Single-subject designs are also characterized by the repeated and regular measure of participants' skills, which would allow documentation of the reading and writing development of students with precision over a longer period of time. Thus, those designs would be especially useful when doing research with students at-risk or experiencing difficulties as it then becomes possible to evaluate the impacts of an intervention on the periodic progress of students with specific characteristics (Horner et al., 2005).

In sum, the present results represent only one piece of the puzzle that is cross-linguistic transfer and biliteracy. More work is needed in order to get a full picture of what knowledge or skill is most likely to transfer and in which context.

Conclusions and Unique Contributions

This matched control intervention study research investigated the impact of a preventative reading intervention in English (L1) on the reading performance in French (L2) of

at-risk elementary school students in Grade 1 and in Grade 2. It was conducted in the greater region of Montreal, in schools offering French Immersion programs. Schools were randomly assigned to one of three experimental conditions in Grade 1 (DMSfV, CBP, CSF) and in Grade 2 (Simplicity, Vocabulary and CSF) Participants within each school received an average of 11-12 hours of intervention in English overall. Cross-linguistic transfer to French was explored. To do so, HLM analyses were conducted in order to take into account the multilevel nature of the data. Significant effects of experimental condition were found in both languages in Grade 1. Following a preventative phonics intervention in English (L1), performance that is consistent with the concept of cross-linguistic transfer to French (L2) could thus be observed in multiple reading outcomes. Additionally, effect sizes for French reading outcomes indicated that results in French were very similar to those for English reading outcomes and that the most important improvements in students' reading were the same in both languages. Thus, those results can be considered as preliminary evidence of the presence of cross-linguistic transfer and thus provide support for Cummins' (1979) developmental interdependence hypothesis (DIH)

Several theoretical hypotheses and correlational studies supported the existence of cross-linguistic transfer by finding important correlations between reading and spelling abilities among bilingual students. However, up until now, no intervention research had been conducted in order to successfully gather stronger evidence supporting the presence of cross-linguistic transfer in reading, specifically when it comes to students at-risk of or already experiencing difficulties. This study is, to our knowledge, the first matched intervention study in the literature to investigate and provide information regarding cross-linguistic transfer in multiple reading outcomes and that, among at-risk students. The results of the present research therefore represent a unique contribution to the scientific literature related to cross-linguistic transfer and

reading development. It provides unique information concerning cross-linguistic transfer from L1 to L2 (English/French) in the context of bilingual education (French Immersion programs) and in the particular linguistic context of Quebec. Using multilevel statistics also made it possible to consider both individual and classroom variation, which is not quite common in biliteracy research. Lastly, a distinguishing aspect of the present study is the fact that diverse L2 word reading skills were measured among the same students, which provides more precise information about specific skills in L2 readers. To our knowledge, no studies in the literature have examined word reading skills in such way. Nonetheless, because of the sample size (i.e. number of level-2 units) and the absence of standardized measures of French reading skills, the present results still need to be interpreted with caution.

The present findings have implications both at the theoretical and practical levels. Thus, at the theoretical level, results support Cummins's DIH and suggest that future developmental models of bilingual reading should take into account the interrelatedness of reading development in both languages. Models should also be able to demonstrate that skills in L1 appear to be transferred directly or indirectly to an L2. In that sense, in light of the present results, it could be speculated that metacognitive skills and phonological awareness constitute non language-specific abilities that support development in multiple languages. At the practical and policy levels, the present results indicate that policies should be oriented towards the establishment of effective teaching practices to support cross-linguistic transfer. Among others, teaching word reading strategies and explicitly teaching about existing similarities and differences between languages as early as Grade 1 could favor cross-linguistic transfer. Lastly, our results indicate that immersion programs can be appropriate for at-risk students. Therefore, those students need not

be removed from those programs but could benefit from supplemental teaching in their L1, which could transfer to their L2.

The results of the present study represent the first step towards a better understanding of the mechanisms supporting cross-linguistic transfer and of the nature of the knowledge that is being transferred. However, many questions regarding cross-linguistic transfer remain unanswered. Replications of the present study, as well as new studies will be necessary to gather enough information to allow us to better understand how to best teach to maximize learning and cross-linguistic transfer in dual-language educational contexts.

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Appendices

List of Appendices

Appendix A

Information Letter for Principals / Teachers Interventions 1 and 2

McGill University. 3700 McTavish Street, Montreal, Quebec, H3A 1Y2
Faculty of Education, Department of Educational and Counselling Psychology
(514) 398-7162

Dear Principal and teachers,

You have been invited to participate in this research study conducted by Dr. Robert Savage and his research team at the department of Educational and Counseling Psychology at McGill University. We are writing to tell you more about this study and request the permission for you to take part in the study.

This is a 5 year project to help us understand the effects of additional literacy supports given to the same group of children each year between Kindergarten and Grade 4. As you know, the teaching of reading is such an important aspect of learning and that our study is focusing on this for 5 years. We are seeking to develop a sustained collaborative relationship with you for this time. We strongly appreciate the involvement of schools in our studies as our research can potentially benefit their students, provide professional development for staff, and with a strong university-school collaboration can impact future generations of readers/learners.

The first year of the project involves both parent- and teacher-supports. For parents we will give opportunities for them to come to workshops giving them information about early reading development and showing them reading activities and skills that they can introduce at home to their child with books and technology. The parent sessions are an entirely optional part of this project. We will also send them ideas and materials to support literacy via newsletters, e-mail and occasionally, through text messaging. All of these additional communications (text-messaging and e-mails) are entirely optional even if parents consent to take part in the study.

At school children in your class will, with parental permission, complete short reading, math, and socio-emotional development tests to determine each child's initial and end of year pre- reading and math abilities and socio-emotional development in kindergarten. We will offer professional development support to you in running pre- literacy programs in the classrooms in the fall semester. These are designed not to teach children to read early but rather to provide solid language and experiential learning to allow their literacy to develop strongly in the future. We will then work with you to support children with these approaches in the classroom through the year. The results from year 1 of the study will provide a base for understanding how parents can be partners with schools in their children's learning. In the following year and beyond, our work will be to help teachers of this same cohort of students to run these literacy programs directly in their classrooms in school. Our research team will help teachers by teaching them new ways to help children support for children over this time. The details of the whole project are outlined in the accompanying 'Overview of the 5-year study'.

What we are asking from schools: Your school's participation is central to this collaborative study. For principals, we are asking you to allow for the project to be conducted in for 4 consecutive years and a follow-up year with the same group of students. We will initially randomly allocate the school to one of three interventions. All interventions reflect best-practices in the field. We seek to work with all children in kindergarten. We can offer a range of supports over time including professional development, in-class support for teachers and students, and in kindergarten, workshops and supports for parents to use at home. Our work will be sustained over time so we will be able to offer an ongoing program of supports that will fit alongside not replace your existing practices.

What we are asking from teacher: The willing participation of individual teachers in this study is similarly central to the success of this project. We ask teachers to attend professional development we will offer on state-of-the-art techniques in early literacy (this will be modest in amount in kindergarten). We ask you to work with a graduate assistant from the university who can help you directly in your classroom implementing some of the ideas we will consider in professional development, evolving some changes in classroom practices that reflect the best-evidence. Occasionally we will observe classrooms to get a sense of how strategies are implemented. This data like all data is confidential and will not be shared within schools or anywhere else except in an anonymous group-data form. We will with your and parent permission, video some sessions for demonstration purposes.

The study has received McGill University Research Ethics approval and has also been approved by your school board.

Confidentiality: All information collected for this study will be kept completely confidential and anonymous. Data will be used for publication purposes in academic journals and will be presented in an anonymous form at all times. Your school's name will not be mentioned in publications. Data will not be circulated within school boards.

Voluntary Participation: Participation in this study is voluntary and no risks are involved in participating in the study.

Withdrawal from the Study: Students at your school can withdraw from the study at any time, or decline to participate for any reason. The decision to terminate participation on any grounds will not affect any relationships with the researcher or McGill University. You may also decide to withdraw your school or class from all or parts of the study.

Questions about the Research: Should you have any questions or desire further information, please email me: Dr. Robert Savage, robert.savage@mcgill.ca, (514) 398 3435

Should you have any ethical concerns regarding this research project, you may contact Lynda McNeil, the Research Ethics Officer of REB- III studies for McGill University, by email at lynda.mcneil@mcgill.ca or by phone at 514-398-6831.

We hope that your school will be part of this valuable ongoing research. We look forward to hearing from you soon.

Sincerely,

Dr. Robert Savage
Professor & Graduate Advisor
Faculty of Education, McGill University

Please indicate whether you wish to allow your child to participate in this project by checking the statement below, signing your name, and having your child sign his/ her name.

Keep the first page for your records, and return this second page with signatures to the classroom teacher.

_____ Yes, I grant permission for my school to participate in the study (principals).

_____ Yes, I grant my permission to participate in the study (teachers).

_____ Yes, I grant permission for my class/ school to be videotaped at school during the study to demonstrate the programs.

Name of School (please print)

_____

Name of Principal / Teacher (please print)

_____

Signature_____

Date_____

Appendix B

Parent ou Tuteur Légal (Intervention)

McGill University. 3700 McTavish Street, Montreal, Quebec, H3A 1Y2
Faculty of Education, Department of Educational and Counselling Psychology
(514) 398-7162

Cher parent ou tuteur légal,

Vous avez été invités à participer à un projet de recherche dirigé par Dr. Robert Savage et son équipe au département de psychopédagogie et de counseling à l'Université McGill. Nous demandons maintenant votre consentement afin que vous et votre enfant puissiez participer à cette étude.

Ce projet de recherche se déroulera sur cinq ans et nous aidera à comprendre les effets d'un soutien scolaire additionnel au niveau académique et social pour les élèves. Ces divers types de soutien seront attribués aux mêmes groupes d'élèves chaque année, de la maternelle à la 4e année.

La première année du projet vise à fournir du support aux parents, ainsi qu'aux enseignants. En tant que parent, vous aurez l'occasion de participer à des ateliers concernant le développement des enfants en ce qui a trait à la lecture. Les ateliers présenteront également des habiletés et des activités de lecture que vous pourrez introduire auprès de votre enfant à la maison, à l'aide de livres et d'outils technologiques. Ces ateliers sont un aspect entièrement facultatif du projet de recherche. Vous pourrez y assister sur une base volontaire. Nous aimerions également avoir la chance de vous envoyer des idées et du matériel relatifs à la littératie par des lettres informatives, des courriels et occasionnellement, à l'aide de messages texte. Si vous consentez à participer, nous vous assurons que nous n'enverrons pas de messages non sollicités et que les détails de vos coordonnées seront conservés à l'université. Toutes les communications additionnelles (messages texte et courriels) sont entièrement facultatives, même si vous consentez à ce que votre enfant participe à l'étude. Enfin, vous trouverez, joint à cette lettre, un questionnaire pour les parents. Nous en ferons parvenir un court second vers la fin de la maternelle.

À l'école, votre enfant complètera de courts tests de lecture et de mathématique. Cela permettra d'identifier ses habiletés au niveau de la pré-lecture et des pré-mathématiques au début du projet, ainsi qu'à la fin de la maternelle. Aussi, nous formerons et soutiendrons l'enseignant(e) de votre enfant en classe, dans l'implantation de programmes d'intervention préventive en lecture. Les résultats de cette première année de l'étude serviront de support afin de comprendre comment les parents et les écoles peuvent établir un partenariat efficace en ce qui a trait à l'apprentissage des enfants. Lors des années subséquentes du projet, notre objectif sera d'aider les enseignant(e)s à implanter de tels programmes d'enseignement de la lecture

directement dans leur classe. Notre équipe de recherche soutiendra les enseignant(e)s en leur enseignant de nouvelles façons d'aider les élèves. Tous les détails concernant le projet se retrouvent dans le document « Vue d'ensemble des cinq années de l'étude ».

Si vous consentez à votre participation et celle de votre enfant au projet de recherche, soyez assuré que mis à part moi, seulement les membres de l'équipe de recherche qui travaillent sur ce projet auront accès à l'information qui vous concerne, ainsi que celle de votre enfant. Toutes les données récoltées lors de ce projet sont confidentielles, c'est-à-dire que ni votre nom ni celui de votre enfant ne seront rattachés aux informations. À la fin de l'étude, les résultats seront rapportés à l'intérieur de journaux et de présentations scientifiques en tant que résultats de groupe anonymes. De plus, les résultats de votre enfant aux différents tests ne seront pas divulgués à son enseignant, à moins que vous n'y consentiez. Ce consentement additionnel est entièrement facultatif, même si vous consentez à ce que votre enfant participe à l'étude.

Enfin, la participation à cette étude est volontaire et ne comporte aucun risque anticipé. Vous pourrez interrompre votre participation et celle de votre enfant à n'importe quel moment. De plus, votre décision de ne pas participer n'entraînera aucune conséquence sur les relations que vous ou votre enfant entretenez avec son enseignant, l'école qu'il fréquente, les chercheurs ou l'Université McGill. Aussi, même si vous refusez que votre enfant participe à l'étude, il prendra tout de même part aux activités en classe puisqu'elles feront partie du programme d'étude. Également, si votre enfant ne participe pas à l'étude, toute information collectée ne sera pas utilisée et sera immédiatement détruite. Finalement, dans le cadre de ce projet, nous aimerions occasionnellement filmer le travail effectué en classe, afin d'être en mesure de démontrer la nature des programmes d'enseignement implantés. Ceci est aussi un aspect facultatif du projet de recherche, si jamais vous décidez d'y participer.

Si vous désirez obtenir davantage d'information ou encore poser des questions, vous pouvez m'envoyer un courriel : Dr. Robert Savage, robert.savage@mcgill.ca, (514) 398-3435.

De plus, si vous avez des questions ou des inquiétudes relativement aux droits ou au bien-être de votre enfant en tant que participant à cette étude, vous pouvez contacter l'officier d'éthique en recherche Lynda McNeil par téléphone, (514) 398-6831, ou par courriel lynda.mcneil@mail.mcgill.ca

Sincèrement,

Dr. Robert Savage
Professeur agréé
Faculté d'Éducation, Université McGill

Si vous désirez donner votre consentement à la participation de votre enfant à ce projet de recherche, veuillez cocher les affirmations qui vous conviennent plus bas et apposez votre signature ainsi que le nom de votre enfant.

Veuillez garder les deux premières pages pour vos dossiers et retourner la troisième avec votre signature et le nom de votre enfant à l'enseignant(e) de votre enfant.

____ Je consens à ce que mon enfant participe à l'étude

____ Je consens à ce que mon enfant soit filmé à l'école pendant les activités pédagogiques reliées à l'étude, afin que les vidéos soient utilisés pour démontrer les programmes d'enseignement (consentement facultatif)

____ Je consens à ce que les informations relatives à mon enfant soient partagées avec son enseignant(e) (consentement facultatif).

_____
Signature du parent/tuteur légal

_____
Nom du parent/tuteur légal en caractères d'imprimerie

_____ _____
Nom de l'enfant en caractères d'imprimerie Date

Votre courriel _____ (facultatif)

Votre numéro de téléphone cellulaire _____ (facultatif)

Appendix C

Solity and Vousden (2009)'s List of 100 Most Frequent Words in English

Words marked with an asterix have been classified as polysyllabic. Words followed by a tick can be decoded with the GPCs listed in Table 5.

a		come		into *		once		they	
about *		could		is		one		this	
after *		did	✓	it	✓	other *		three	✓
all		do		last	✓	our *	✓	time	✓
am	✓	down		like	✓	out	✓	to	
an	✓	for	✓	little *		over *		today *	
and	✓	from	✓	live		put		too	✓
are		get	✓	look		said		two	
as		go		made	✓	saw	✓	up	✓
at	✓	got	✓	make	✓	see	✓	us	
away *		had	✓	me		she		very *	
back	✓	has		my		so		was	
be		have		new		some		we	
because *		he		next	✓	take	✓	went	✓
big	✓	her	✓	not	✓	that		were	
but	✓	here		now		the		what	
by		him	✓	of		their		when	✓
call		his		off	✓	them		will	✓
came	✓	I		old		then		with	
can	✓	in	✓	on	✓	there		you	

Appendix D

Solity and Vousden (2009)'s List of Most Frequent GPCs

Grapheme	Phoneme	Example Word
t	t	*t*ap
s	s	*s*it
l	l	*l*og
p	p	*p*in
r	r	*r*at
n	n	*n*et
d	d	*d*ig
s	z	pin*s*
m	m	*m*at
k	k	*k*ing
b	b	*b*at
i	ɪ	b*i*g
sh	ʃ	*sh*op
c	k	*c*at
f	f	*f*an
u	ʌ	b*u*g
w	w	*w*in
a	æ	c*a*t
g	g	*g*et
h	h	*h*at
e	e	b*e*d
ee	iː	b*ee*n
o	ɒ	d*o*g
a*e	eɪ	m*a*k*e*
ch	tʃ	*ch*ip
pp	p	sto*pp*ed
ng	ŋ	ri*ng*
ck	k	ba*ck*
ll	l	we*ll*
v	v	*v*an
i*e	aɪ	l*i*k*e*

ea	iː	b*ea*d
ed	d	stopp*ed*
ss	s	cla*ss*
th	θ	*th*in
o*e	əʊ	b*o*n*e*
n	ŋ	si*n*k
ai	eɪ	p*ai*nt
aw	ɔː	p*aw*
ir	ɜː	b*ir*d
tch	tʃ	wa*tch*
j	dʒ	*j*am
ff	f	stu*ff*
y	j	*y*es
ar	aː	b*ar*n
c	s	fa*c*e
igh	aɪ	n*igh*t
oa	əʊ	b*oa*t
dg	dʒ	bri*dg*e
ou	aʊ	*ou*t
wh	w	*wh*at
ed	t	pass*ed*
z	z	*z*oo
ay	eɪ	pl*ay*
or	ɔː	b*or*n
g	dʒ	ca*g*e
oo	uː	f*oo*d
th	ð	*th*e
ow	aʊ	n*ow*
qu	kw	*qu*ick
x	ks	fo*x*
ow	əʊ	kn*ow*
ur	ɜː	b*ur*n
kn	n	*kn*ow
gg	g	e*gg*
oi	ɔɪ	v*oi*ce
i	aɪ	f*i*nd
air	eə	h*air*

eer	ɪə	ch*eer*
ore	ɔː	m*ore*
ear	ɪə	d*ear*
oo	ʊ	b*oo*k
are	eə	sh*are*
bb	b	gra*bb*ed
ea*e	iː	l*eav*e
y	aɪ	m*y*
ie	aɪ	p*ie*
oar	ɔː	r*oar*
er	ɜː	h*er*
mb	m	la*mb*
o	əʊ	n*o*
al	ɔː	w*al*k
a	aː	l*a*st
ea	e	h*ea*d
oo*e	uː	g*oos*e
gn	n	sig*n*
oor	ɔː	d*oor*
wr	r	*wr*ite
ew	ju	kn*ew*
mm	m	slam*m*ed
u*e	ju	*us*e
nn	n	grin*n*ed
ew	uː	fl*ew*
u	ʊ	p*u*t
ee*e	iː	ch*ees*e
e*e	e	*e*ls*e*
es	z	go*es*
ar*e	aː	l*arg*e
ph	f	*ph*one
e	iː	w*e*
ear	ɜː	h*ear*d
our	ɔː	y*our*
ie	iː	f*ie*ld
d	t	like*d*
zz	z	buz*z*

ar	ɔː	w*ar*m
oy	ɔɪ	t*oy*
dd	d	o*dd*
ch	k	*ch*ool
au	aː	l*au*gh
i*e	ɪ	g*iv*e
au	ɔː	f*au*lt
or*e	ɔː	h*or*s*e*
qu	k	*qu*ay
ue	uː	tr*ue*
y	ɪ	g*y*m
gh	f	lau*gh*
au*e	ɔː	p*aus*e

Appendix E

Experimental Nonword List for Grade 1

Mots		**C/I**	**Réponse**
fur			
moire			
treu			
nale			
linte			
donfe			
nème			
fagne			
flé			
chir			
vabe			
dimme			
leudu			
niter			
bassi			
linta			
phito			
baudi			
gila			
bévis			
fimeau			
cipar			
larper			
vamoir			
loupru			
deuflé			
lènade			
tarni			
flandi			
bluma			

Appendix F

Experimental Nonword List for Grade 2

Mots	**C/I**	**Réponse**
saibre		
tinfre		
meufle		
truge		
fèpre		
citre		
paci		
luder		
doipir		
ratagne		
bideau		
phobine		
flitère		
brissade		
soinfure		
baltain		
troivure		
bargir		
gibaton		
dipoter		
infodu		
missalit		
labuteux		
mativeau		
puifible		
tilaphine		
bauframé		
cirmupé		
friboleur		
larchidu		

Appendix G

Experimental Grapheme to Phoneme Conversion Task Measure

Grade 1

Mots	**C/I**	**Réponse**	**Mots**	**C/I**	**Réponse**
ph			eau		
an			é		
on			è		
ou			eu		
in			oi		
au			en		
ai					
er					
gn					

Grade 2

Mots	**C/I**	**Réponse**	**Mots**	**C/I**	**Réponse**
ci			er		
gi			ain		
ph			eau		
gn			eu		
au			oi		
ai			oin		
in					
ch					
ou					

Appendix H

Experimental Spelling Experimental Measure

1. preu (/p r ø/)
2. vra (/v r a/)
3. fugne (/f y ɲ/)
4. rade (/r a d/)
5. sitru (/s i t r y/)
6. vèpron (/v ɛ p r ɔ̃/)
7. gadi (/g a d i/)
8. noulin (/n u l ɛ̃/)
9. curvo (/k y r v o/)
10. chourlan (/ʃ u r l ɑ̃/)
11. mébasson (/m e b a s ɔ̃/)
12. jitabi (/ʒ i t a b i/)

Appendix I

Typical Lesson for the Preventative Intervention Based on the Simplicity Principle

5 minutes

Reviewing previous lessons helps students to solidify the information and puts them on track for today's lesson.

Review Previous Lesson

TIP: Wait 10 seconds before choosing a student.

ASK: Do you remember what word we learned yesterday (or during the previous lesson)?

ANSWER: Last lesson we learned the word "each".

ASK: Who remembers the special spelling for "each"?

TIP: Choose 2 students and ask them to come to the blackboard. Use 2

ANSWER: The special spelling was "c-h" which makes the "ch" sound.

1-2 minutes

Asking questions allows students to go from passive learners to active learners.

Introduction

TIP: Wait 10 seconds. Choose 1-2 answers.

ASK: Today we will learn a new word. Do you know the word dark?

ANSWER: Dark means with little or no light.
For ex. I can't see much. It's too dark.
Carolyn was sitting in the dark.

TIP: Check students' reactions. Are they confused? If so, give another

1-2 minutes

By having students try to spell out the words themselves, they will become engaged in the lesson and be motivated to learn.

Try Spelling the Word

SAY: Let's try spelling the word dark in your notebook.

Having trouble?

If students are unable to write the letters, give letters from the kit and have them try to build the word.

Give lots of encouragement! Mistakes show you are trying!

1-2 minutes

The correct spelling is very important, so make sure everyone in the class can see the word clearly!

The Big Reveal!

SAY: Good job! Let's see how close you were to the spelling.

ACTION: Write dark on the board.

SAY: *Dark is spelled d-a-r-k.*

Walk around and make sure everyone is copying down the word correctly.

Write the correct word in your notebook.
Be sure to write it carefully!

2 minutes

Physically manipulating the letters helps to further solidify their spelling.

Build it

ACTION: Erase the word on the board.

SAY: Close your notebook and find the letters th
spell dark.

SAY: EXCELLENT WORK CLASS!

Go around the room and make sure everyone has their letters. Help those who seemed confused by repeating the directions but have them try to spell it themselves.

5-8 minutes

Giving students a reason to pay attention to the words in the book helps to build on their audio and visual recognition of the word.

Find the Word in the Book

SAY: Now let's read a book and try to find the word we just learned.

Munch, R. & Martchenko, M. *The Dark.* Scholastic.

When the word comes up,

SAY: Look, is that the word we just learned? Yes it is! Dark.

1-2 minutes

Asking questions allows students to go from passive learners to active learners.

Introduce Special Spelling

SAY: Dark has a special spelling unit. Can anyone guess what it is?

SAY: Great answer. Who else?
Yes, another fantastic answer!
One more try! Who else?
All excellent guesses!

***TIP**: Wait 10 seconds. Choose 1-2*

1-2 minutes

Make sure everyone in the class can see the circled letters clearly!

Reveal the Special Spelling

SAY: The word dark has a spelling pattern "ar".

ACTION: Circle *"ar"* in a different colour

SAY: *"ar"* can be found at the *middle* of a word and usually makes the sound *"arrr"*.

You can give them another example that makes the same sound: art.

10 minutes

Find Words with the Special Spelling

SAY: Here are some pages from the book.
In groups of 4-5, find words with "a-r" that make the "arr" sound.

SAY: Do not shout out the answer. When you find the word, circle it quietly. There may be more than one word with the "a-r" that makes the "arr" sound, look CAREFULLY! I want each person in the group to have the chance to read the whole page.

Once everyone is done,

SAY: Share your answer with your group. When your group agrees on the answer put up your hand. I will ask for answers when the groups have their hands up.

ACTION: While students are doing this, prepare chalk for each group/ or markers, to write on the board.

ACTION: Choose a student from each group, try to pick a student who has not participated today.

ACTION: Pick a second student from the group to underline the special spelling.

SAY: Write down all your answers clearly on the board.

SAY: Let's go through each word. Repeat the word after me.

SAY: **FANTASTIC WORK EVERYONE!**

 **10 minutes**

Write Word in Notebook

SAY: Open your notebook.
Let's use dark in a sentence.
Write it in your notebook.

Having Trouble?

If students are struggling, you can ask students to come up with a sentence, choose 2-4 students to say their sentences, and write down the sentences on the board for everyone to copy.

 **1-2 minutes**

Wrap up

SAY: Great job today! You all get a sticker for your hard work! What was the word we learned today? *Dark*

Reward groups that worked very well together.

1) Verbally by acknowledging them and saying how you appreciated how well they worked together, or with an additional sticker.

OR

2) Use your current class reward system.

 **5 minutes**

Your Thoughts of the Lesson

Take a moment to jot down some notes about the lesson.

- Did students spell the word correctly?
- Did they understand the lesson?
- How was the pace of the lesson?
- Were there students who struggled?
- Were there any who should or should not work together next time?

Appendix J

Typical Lesson for the Preventative Intervention Oriented Towards Vocabulary

5 minutes

Reviewing previous lessons helps students to solidify the information and puts them on track for today's lesson.

Review Previous Lesson

TIP: Wait 10 seconds before choosing a

ASK: Do you remember what word we learned yesterday (or during the previous lesson)?

ANSWER: Last lesson we learned the word "each".

ASK: Who remembers the special spelling for "each"?

ANSWER: The special spelling was "c-h".

TIP: Choose 2 students and ask them to come to the blackboard.

1-2 minutes

Asking questions allows students to go from passive learners to active learners.

Introduction

TIP: Wait 10 seconds. Choose 1-2 answers.

ASK: Today we will learn a new word.
Do you know the word dark?

ANSWER: Dark means with little or no light.
For ex. I can't see much. It's too dark.
Carolyn was sitting in the dark.

TIP: Check students' reactions. Are they confused? If so, give another

We also use **dark** to describe a particular type of humour, when a particular situation seems to be pessimistic, or when something is unknown (mysterious).

For ex. Satire is a sort of dark humour.
September 11th will be remembered as a dark day for humanity.
Peter had hidden his most precious dark secret until today.

SAY: Let's study these other examples by identifying the component of the following sentences (little or no light, humour, pessimism, or mysterious):

- And then he stepped forward, looking elegant in a **dark** tuxedo.
- A long train whistle sounded several times, adding to the **dark** mood of the evening.
- The **dark** comedy we watched last night was very morbid

indeed.

- Did you like the author's new work? No. In my opinion, it was very **dark**.

1-2 minutes

By having students try to spell out the words themselves, they will become engaged in the lesson and be motivated to learn.

Try Spelling the Word

SAY: Let's try spelling the word dark in your notebook.

Having trouble?

If students are unable to write the letters, give letters from the kit and have them try to build the word.

Give lots of encouragement! Mistakes show you are trying!

1-2 minutes

The correct spelling is very important, so make sure everyone in the class can see the word clearly!

The Big Reveal!

SAY: Good job! Let's see how close you were to the spelling.

***ACTION:* Write *dark* on the board.**

SAY: *Dark* is spelled *d-a-r-k*.
Write the correct word in your notebook.
Be sure to write it carefully!

Walk around and make sure everyone is copying down the word correctly.

2 minutes

Physically manipulating the letters helps to further solidify their spelling.

Build it

ACTION: Erase the word on the board.

SAY: Close your notebook and find the letters th
spell dark.

SAY: EXCELLENT WORK CLASS!

Go around the room and make sure everyone has their letters. Help those who seemed confused by repeating the directions but have them try to spell it

5-8 minutes

Giving students a reason to pay attention to the words in the book helps to build on their audio and visual recognition of the word.

Find the Word in the Book

SAY: Now let's read a book and try to find the word we just learned.

Munch, R. & Martchenko, M. *The Dark.*
Scholastic.

When the word comes up,

SAY: Look, is that the word we just learned? Yes it is! Dark.

1-2 minutes

Introduce Special Spelling

Asking questions allows students to go from passive learners to active learners.

SAY: Dark has a special spelling unit. Can anyone guess what it is?

SAY: Great answer. Who else?
Yes, another fantastic answer!
One more try! Who else?
All excellent guesses!

***TIP**: Wait 10 seconds. Choose 1-2*

10 minutes

Find Words with the Special Spelling

SAY: Here are some pages from the book.
In groups of 4-5, find words with "a-r".

SAY: Do not shout out the answer. When you find the word, circle it quietly. There may be more than one word with the "a-r", look CAREFULLY! I want each person in the group to have the chance to read the whole page.

Once everyone is done,

SAY: Share your answer with your group. When your group agrees on the answer put up your hand. I will ask for answers when all the groups have their hands up.

ACTION: While students are doing this, prepare chalk for each group/ or markers, to write on the board.

ACTION: Choose a student from each group, try to pick a student who has not participated today.

ACTION: Pick a second student from the group to underline the special spelling.

SAY: Write down all your answers clearly on the board.

SAY: Let's go through each word.

SAY: **FANTASTIC WORK EVERYONE!**

10 minutes

Write Word in Notebook

SAY: Open your notebook.
Let's use dark in a sentence.
Write it in your notebook.

Having Trouble?

If students are struggling, you can ask students to come up with a sentence, choose 2-4 students to say their sentences, and write down the sentences on the board for everyone to copy.

1-2 minutes

Wrap up

SAY: Great job today! You all get a sticker for your hard work! What was the word we learned today? *Dark*

Reward groups that worked very well together.

1) Verbally by acknowledging them and saying how you appreciated how well they worked together, or with an additional sticker.

OR

2) Use your current class reward system.

5 minutes

Your Thoughts of the Lesson

Take a moment to jot down some notes about the lesson.

- Did students spell the word correctly?
- Did they understand the lesson?
- How was the pace of the lesson?
- Were there students who struggled?
- Were there any who should or should not work together next time?