

**Tracking Early Literacy Development and COVID-19 Learning Loss**

by

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A Dissertation Proposal Submitted in Partial Fulfillment of the  
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DOCTOR OF PHILOSOPHY

In Educational Psychology

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We acknowledge and respect the Ləkʷəŋən (Songhees and Xʷsepsəm/Esquimalt) Peoples on whose territory the university stands, and the Ləkʷəŋən and W̱SÁNEĆ Peoples whose historical relationships with the land continue to this day.

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**Tracking Early Literacy Development and COVID-19 Learning Loss**

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### **Abstract**

The COVID-19 pandemic significantly disrupted global education, amplifying the need to understand its long-term effects on literacy development. This multi-study dissertation examines the impact of COVID Learning Loss (CLL) on foundational reading skills in early elementary students. Paper 1 investigates a cohort of students who were in Grade 1 during the 2020 pandemic school closures and who were assessed one year after regular instruction resumed. Results revealed that 74% of students remained at risk in on or more foundational reading skills, such as vocabulary, phonological awareness, and decoding, performing comparably to peers with no prior English instruction, suggesting an enduring floor effect. Paper 2 extends the analysis, tracking 247 students through Grade 4. While recovery from CLL was ongoing, most students had not regained pre-pandemic achievement levels by Grade 4. Notably, typical protective factors, such as SES and vocabulary, had limited influence on recovery rates, indicating a broad, systemic impact on learning during critical developmental phases. These findings emphasize the urgent need for comprehensive academic recovery plans, as resilience alone is insufficient for spontaneous recovery, raising concerns about future academic and societal outcomes without targeted interventions.

*Keywords:* foundational reading skills, COVID -19 pandemic, COVID learning loss, educational disruptions, component reading skills, direct and indirect effects of reading model (DIER), phase theory of reading development, risk factors, protective factors

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“Improvise, overcome, and adapt!” (Marcel Boulet, Nov 1<sup>st</sup>, 2022)

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## Chapter I: General Introduction

Understanding what we read is a multifaceted yet fundamental skill crucial for both academic achievement, future success and prosperity. The early stages of literacy acquisition rely heavily on the development of foundational component reading skills. A breakdown in these foundational skills can lead to significant difficulties in reading comprehension (Gough & Tunmer, 1986), potentially resulting in long-term literacy challenges that permeate into adulthood (National Early Literacy Panel, Lonigan et al., 2008; Ritchey et al., 2013). This dissertation investigates to what extent disruptions in education alter the developmental trajectory and acquisition of foundational reading skills. This question gains heightened relevance in light of recent disruptions caused by the COVID-19 pandemic, which have sparked increased interest in summer learning loss (SLL) research in understanding the impact of longer disruptions on learning outcomes (Atteberry & McEachin, 2020; Kuhfeld et al., 2022, Tomasik et al., 2021). Educational interruptions, whether due to pandemics, natural disasters, or other unforeseen circumstances, can disrupt the continuity of learning and potentially impede the development of essential reading skills among students.

This dissertation is comprised of two primary studies, detailed in chapters 3 and 4 respectively. Chapter 2 provides an overview of the educational context and a comprehensive literature review of the development of reading skills among primary students, viewed through the lens of information processing theory (Atkinson & Shiffrin, 1968), risk and resiliency theories (Bronfenbrenner & Morris, 2006; Masten, 2014; 2020) and prominent reading theories such as the direct and indirect effect model of reading (DIER; Kim, 2017, 2020), and phase theory of reading development (Ehri, 2005, 2020). Additionally, this chapter explores the connections between component reading skills and these reading theories. Chapter 5 synthesizes the findings from the two studies, discusses their educational implications, and offers directions for future research endeavors aimed at better understanding the impact of educational disruptions on the acquisition of foundational reading skills.

## Research Aims and Scope

While a burgeoning body of research addresses Covid learning loss (CLL), notable gaps persist within the field. One such gap pertains to the insufficient exploration of potential enduring impacts of literacy loss among primary students over the long-term. The studies conducted thus far have primarily focused on the short-term effects of the pandemic on literacy achievement. However, it is crucial to understand the long-term implications of the pandemic on student literacy development. The proposed series of studies will explore key factors that contribute to early reading development by following a group of students, from the British Columbia school system, who were in Grade 1 when Covid lockdowns began. This cohort was comprised of students enrolled across five elementary schools, three English and two French immersion.

This research seeks to understand how disruptions to education impact the expected trajectory of developmental reading skills. Specifically, the research will explore how disruptions affected the acquisition of component reading skills including, vocabulary, phonological awareness (PA), word level reading, decoding, and reading fluency. The first study examines what proportion of students, who were in Grade 1 when COVID lockdowns began, were falling below expectations on component literacy skills based on standardized norm-referenced measures, and whether the proportion falling below expectation exceeded historically-documented levels preceding the pandemic. The second study is a longitudinal study that expanded from the first study and tracked the cohort of students and their literacy skills over 3 waves of data collection. Additionally, this research aims to explore the risk and protective factors that may have contributed to literacy learning loss and recovery among primary students post pandemic disruptions, such as vocabulary, phonemic awareness, social-economic status (SES) and cultural and linguistic differences (i.e., indigenous ancestry, French immersion instruction). Several frameworks form the theoretical underpinnings which guide the proposed research, including information processing theory (Atkinson & Shiffrin, 1968), the direct indirect effects of reading model

(DIER) (Kim 2017, 2020), and phase theory of reading development (Ehri, 2005, 2020). These theoretical underpinnings help explain learning loss, the dynamic and interactive nature of direct and indirect influences on reading and conceptualize the periods of reading development at which time children typically consolidate certain cognitive processes and skills that support reading.

By understanding how disruptions to education affect the normal developmental trajectory of component reading skills, researchers can affirm and identify the critical points or transitions in a student's reading development. This research, when assessed against the phase theory of reading development (Ehri, 2005) will potentially provide a broader understanding of the theory and its application to the development of foundational component reading skills. An investigation into the various ways that individual students or groups recover from sustained learning loss following disruptions can help identify direct and indirect factors related to the DIER (Kim 2017, 2020) model of reading and inform the growing body of research supporting the theory. Moreover, an understanding of the specific gaps in skill development along with protective factors and risk factors will enable educators to utilize a more focused approach to the remediation of lagging skills. This knowledge can inform the development of effective school wide structures and policies to maximize limited resources, time, and personnel, and mitigate the negative impact of future educational disruptions on student's literacy development. Furthermore, this research can provide insights into the long-term effects of formal educational disruption (e.g., pandemic, climate disasters, war etc.) on primary students' developing component reading skills and the effects that these disruptions have on reading development.

## **Chapter II: Literature Review**

In March of 2020, the COVID-19 pandemic led to widespread school closures and a movement to remote learning, causing concerns about potential learning loss among students. Early in the pandemic, school psychologists around the world were concerned about unnecessarily over-diagnosing children with learning disabilities who simply had gaps in their learning due to pandemic disruptions

(National Association of School Psychologists (NASP), 2020a & NASP, 2020b). With school closures, remote learning, and hybrid models of instruction, students faced numerous challenges in maintaining their academic progress. According to a report by the National Assessment of Educational Progress (NAEP 2022), most students in the United States have lost some ground in reading since the pandemic began. The report found that in 4th grade, the percentage of students who scored below basic level in reading increased by 6 points compared to 2019, and in 8th grade, the percentage increased by 8 points. These results demonstrate that the pandemic caused significant learning loss in reading.

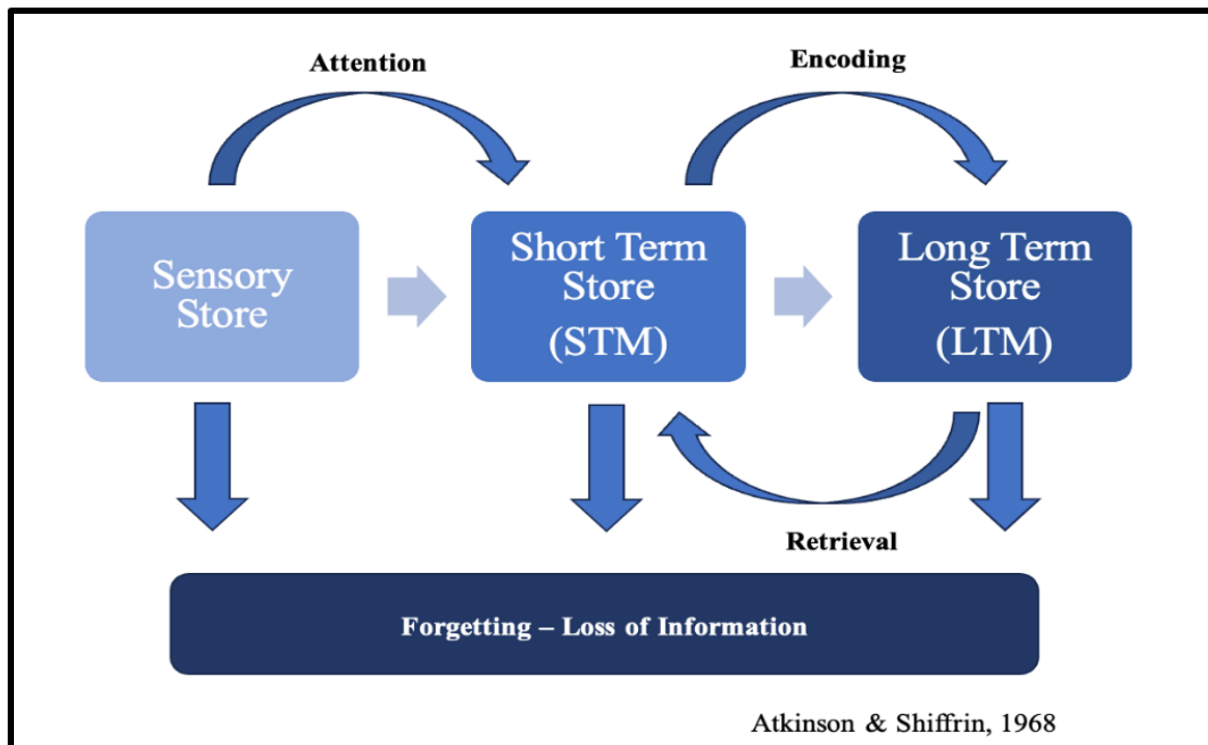
One area of particular concern has been literacy learning loss among primary students. While research on covid learning loss (CLL) is ongoing, some studies indicate that children who were in primary grades when lockdowns began may have experienced significant impacts on their early literacy development (Tomasik et al., 2021). The shift to remote learning may have been particularly challenging for young children, due to their limited practice using technology for formal instruction, lack of independence, and underdeveloped executive function skills (Tomasik et al., 2021). Many children may have lacked access to technology or the internet, which would have made it difficult to participate in virtual learning. Additionally, the absence of face-to-face interaction with teachers and peers along with the later use of protective masks, may have reduced opportunities for language and literacy development. The pandemic may also have disrupted important early literacy activities, such as reading aloud and story time, which are critical for language development and building vocabulary. Because public libraries, bookstores, and other community resources were closed or limited, many families had reduced access to reading materials and support for early literacy development. A study by Kuhfeld et al. (2020) found that students in Grades K-2 had experienced significant losses in reading proficiency during the first months of the pandemic. According to the study, students in this age group lost an average of 5-6 months of reading progress. This is a cause for concern, as early literacy development is critical for future academic success.

### Learning Loss and Information Processing Theory

Information processing theory as a theoretical framework provides valuable insights into explaining COVID-related learning loss in young readers; however, the theory itself was not directly tested in this study. This theory posits that the human mind processes information through a series of stages, (see Figure 1) including encoding, storage, and retrieval, similar to how a computer processes data (Atkinson & Shiffrin, 1968). Information can be lost during each of the information processing stages which helps to explain learning loss in the context of disruptions caused by the COVID-19 pandemic.

**Figure 1**

*Information Processing System*



#### *Sensory Register*

The first step in Information Processing Theory involves the sensory register, where individuals initially perceive environmental information through their senses: vision, hearing, touch, smell, and

taste. Each sense possesses its own register or memory system that briefly retains information in the exact format in which it was received (Wolfe, 2010). Information only remains in sensory memory for less than 0.25 seconds (Mayer, 2012) until a determination is made regarding its further processing. A small portion of the sensory input is subsequently transferred to working memory for further processing, while as much as 99% of other stimuli are dropped and substituted with new incoming data (Gazzaniga et al., 2018). This sensory memory serves as a filtering mechanism, essential for managing the vast volume of sensory information we encounter, effectively discarding irrelevant or superfluous information (Wolfe, 2010).

For young readers the sensory registry holds the initial key to determining what information is discarded or retained and may have been impacted by COVID disruptions in several important ways. External stimuli, such as reading materials and instructions from teachers, must first be transformed, or encoded, into mental representations. During the pandemic, many students experienced disruptions in their learning environment including limited exposure to sensory-rich classrooms (e.g., sound / word walls) and reduced access to developmentally appropriate reading materials. Moreover, they had to adapt to remote learning, which often lacked the interactive and engaging aspects of in-person education with expert instructors managing and redirecting student attention as needed. Attention plays a critical role in processing information (Wolfe, 2010). This reduced sensory input for reading instruction could have impacted their engagement and motivation to learn. On the other hand, the move to online learning may have equally caused sensory overload, including “Zoom fatigue”, (Bailenson, 2021; Fauville, et al., 2021; Serhan, 2020; Toney, et al., 2021) leaving little available energy for attending to and processing relevant reading stimuli and instructions. Furthermore, shared home computers with software that was not optimally configured for learning, such as having alerts turned off, and screen badges and email delivery sounds disabled, which then competed for sensory attention. Increased screen time associated with remote learning therefore contributed to sensory overload

(Bailenson, 2021) and could have affected young readers' attention spans, potentially leading to decreased focus during reading activities.

Another important factor impacting the sensory register for young readers was the use of masks after the return to school. Wearing masks disrupted the sensory registry for incoming phonological information. In addition, masks impeded visual input by blocking the ability to look at the speaker's mouth, which often helps the listener differentiate between similar phonemes (e.g. /M/ &/N/) (Bernstein, 2012; McGurk, & MacDonald, 1976; Peelle & Sommers, 2015). Because incoming sensory information only remains in the sensory registry momentarily, then fades, and is lost (Atkinson & Shiffrin, 1968), this change in input processes could have hindered students' ability to effectively encode and process information related to sound and symbol correspondence – a foundational skill for early literacy (Mousty & Kolinsky, 1998, p. 130). Collectively these factors contributed to the attrition of information from the sensory registry before it could even transition to short-term working memory which is the second part of the information processing system.

### ***Short-Term Memory and Working Memory***

Information Processing Theory emphasizes the importance of the limited capacity, short-term memory system, which temporarily holds and processes information. According to The Cattell-Horn-Carroll (CHC) theory of cognitive abilities, short-term memory includes two primary functions a) memory span, and b) working memory capacity (Schneider & McGrew, 2012). Short-term memory pertains to the ability to retain information in one's immediate consciousness and subsequently utilize it within a brief timeframe (Schneider & McGrew, 2012). In the absence of deliberate rehearsal or continuous focus, data is retained in short-term memory for approximately 15 to 20 seconds, (McGee & Wilson, 1984) before it is either lost, or transferred to long-term memory.

Short-term memory span is the ability to retain a specific sequence of information in primary memory and subsequently reproduce the information in the same order in which it was originally

presented (Schneider & McGrew, 2012). Disruptions caused by the pandemic, such as changes in learning environments, increased distractions at home, or reduced teacher-student interaction, could have impeded young readers' ability to concentrate, rehearse, and retain sequences of information. Consequently, young readers' ability to retain the sequence of letters when learning to read and sound out unfamiliar words was likely impacted further delaying reading development.

Working memory is also part of the short-term memory system and is crucial for active cognitive processing. Unlike memory span where one simply holds a sequence of information in mind, working memory involves using, manipulating or transforming the information in some way. According to CHC theory, working memory capacity is "the ability to direct the focus of attention to perform relatively simple manipulations, combinations, and transformations of information within primary memory, while avoiding distracting stimuli and engaging in strategic/controlled searches for information in secondary memory" (Schneider & McGrew, 2012, p. 5).

This ability is important for reading comprehension (Ashbaker & Swanson, 1996) where a young reader must first hold individual letters and their associated sounds (phonographs) in mind to decode words, and then hold individual words in working memory until they have finished reading the sentence. At which point the student must combine the information in order to gain meaning from the text while drawing on background knowledge from long term-memory for comprehension (Smith et al., 2021).

COVID-19 disruptions and related stressors, such as concerns about health, family, and overall uncertainty, in combination with increased distraction and reduced teacher interaction may have overloaded the working memory of many young readers. This overload likely made it challenging for many students to concentrate (Toney, 2021) on reading instruction from the teacher and more difficult for them to effectively process and comprehend reading materials (Chen et al., 2011). Working memory enables us to amalgamate present sensory data with pre-existing knowledge and to deliberately manipulate this information to facilitate the encoding of information into long-term memory (Wolfe,

2010). The fallout for young readers experiencing working memory overload is less information, such as knowledge of phonics rules and standard orthographic patterns, being transferred to Long Term Memory.

### ***Long-Term Memory and Consolidation***

Learning and retaining information over the long term depends on the transfer of knowledge from working memory to long-term memory. The interruption of regular in-person instruction might have hindered the consolidation of new knowledge into long-term memory for young readers. Long-term memory is responsible for storing information and knowledge acquired over an extended period (Schneider & McGrew, 2012). During the regular school year, students build up their long-term memory by learning various skills through repeated exposure and retrieval practice. However, when they have an extended break students may not engage in activities that reinforce or recall the knowledge or skill. As a result, some of the information may fade or become less accessible in their long-term memory. Many academic skills, such as letter-sound correspondence, decoding, fluency and reading comprehension, rely on long-term memory (Alsius et al., 2020). Students need to remember and apply these skills consistently to develop and maintain proficiency (Alsius et al., 2020). Disruptions to education can impact students recall if they do not engage in activities that challenge their long-term memory. Retrieving information from long-term memory requires regular practice. During the pandemic, students might not have been exposed to as many opportunities for them to recall and utilize what they've learned. Without consistent retrieval and practice, knowledge stored in long-term memory can become less accessible. Covid-related learning loss might manifest in young readers' struggles to recall and apply reading strategies and concepts acquired before the pandemic. Consequently, newly acquired skills are more easily forgotten. The six-month gap in regular face to face instruction resulted in cumulative learning loss at each of the information processing stages. Suggesting an impact on the normal trajectory of students' developing reading skills. Typically, throughout the course of reading

development, children expand and grow cognitive connections in their working memory and their long-term storage and retrieval skills that support consolidation of word level reading capacity (Ben-Yehudah & Fiez, 2007, pp. 315-317).

### **Reading Theories**

Intertwined with the overarching concepts of information processing theory are the intricate cognitive and linguistic processes that require the coordination of various skills and knowledge when a student learns to read. Numerous theoretical frameworks have been advanced, offering comprehensive and nuanced insights into the multifaceted nature of factors influencing reading including the simple view of reading (Gough & Tunmer, 1986; Hoover & Gough, 1990), the multicomponent view of reading (Cain, 2009), the componential model of reading (Joshi & Aaron, 2000, 2012), and the reading systems framework (Perfetti & Stafura, 2014) to name a few. A more contemporary and integrative model was proposed by Kim (2017; 2020) called the direct and indirect effect model of reading (DIER; Kim, 2017; 2020). While these reading theories provide essential theoretical foundations for understanding the complexities of literacy development and learning loss, no specific theory was directly tested in this study. DIER is a theoretical framework that aims to explain the complex interplay of various cognitive processes involved in reading comprehension and incorporates many of the concepts previously outlined in the information processing theory including attention control, working memory, and background knowledge. This model posits that reading comprehension is influenced by both direct and indirect factors. Direct factors refer to the specific cognitive processes directly related to decoding and comprehension, such as phonological awareness, fluency, vocabulary knowledge, and syntactic skills. These factors directly contribute to a reader's ability to decode words and understand text. Indirect factors, on the other hand, are broader cognitive constructs that indirectly impact reading comprehension through their influence on direct factors. These include social, emotional, and cognitive factors, all of which were potentially negatively impacted by Covid disruptions to education.

Moreover, theories such as Bronfenbrenner's (2005) bioecological framework speak to even broader indirect factors (e.g., relationships, socioeconomics, environmental influences), that may impact how students learn to read (Nadori, 2020). These broader influences align with the second study's examination of the influence both external and internal on the long-term effects of disruption in formal literacy learning. While not directly involved in developing decoding or comprehension skills per se, these indirect factors play a crucial role in supporting and facilitating the development of direct reading skills (Kim, 2017; 2020; Nadori, 2020).

The progression in the acquisition of reading skills has frequently been described as a series of developmental stages (Chall, 1983; Ehri, 1991; Frith, 1985; Gough & Hillinger, 1980; Marsh, et.al., 1981). Linnea Ehri's (2005a) phase theory of reading development outlines four key stages in learning to read words including a) the pre-alphabetic phase, b) the partial alphabetic phase, c) the full alphabetic phase, and d) the consolidated alphabetic phase. These phases represent a developmental progression in the acquisition of reading skills, underscoring the importance of phonetic awareness and the transition from reliance on visual memorization in early phases to understanding and applying letter-sound relationships (Ehri, 2005) later in development. Ehri's developmental phases highlight distinctions in how children engage with the alphabetic code, forming connections between a word's visual appearance, its auditory (phonological) representation, and its meaning (Ehri, 2005). Moreover, neural imaging studies seem to corroborate the concept of developmental reading phases with shifting brain activation as reading skills mature (e.g., Gaillard et al., 2003; Maurer et al., 2006; Parviainen et al., 2006).

The first stage of Ehri's theory is known as the pre-alphabetic phase where young readers rely on visual features and memorization without a strong connection to letter-sound relationships. According to Frith (1985) this "logographic" or "pictorial" reading stage typically emerges at approximately five or six years of age and often precedes formal literacy instruction. Children entering kindergarten are generally in the pre-alphabetic stage. They might recognize their name or commercial

signs (e.g. Toys r Us) but they are not yet decoding the “internal structure of the word” (Dehaene, 2009, p. 200). At this developmental stage, the child's brain (specifically regions in the right hemisphere) endeavors to associate the overall shape of words directly with their meanings, without focusing on individual letters and their corresponding pronunciation (Dehaene, 2009, p. 207). For children participating in the present study, formal literacy outcomes based on provincial curricula state that by the start of Grade 1, children will be able to recognize and name most letters of the alphabet, recognize most letter-sound matches, and recognize some familiar words /names and environmental print (e.g., street signs, food packaging)(BC Ministry of Education).

The next stage in Ehri's Phase Theory of Reading Development is the partial alphabetic phase where readers start associating some letters with specific sounds but may not fully understand the alphabetic principle. Studies suggest that as early as the age of seven, (e.g., Grade 2) activation in the typical neural network used by proficient readers (i.e., in the left hemisphere) begins to be detected at the sight of printed words (Gaillard et al., 2003; Maurer et al., 2006). The activation observed in this context is extensive and occurs in both hemispheres, indicating that a significant portion of the visual system is engaged in the reading process (Dehaene, 2009). The fact that left hemisphere activation begins to appear while still maintaining activation on the right, suggests that a mixture of shape and letter sound correspondence is utilized in the reading process and aligns with Ehri's partial alphabetic phase. According to Ehri, during this phase children use a combination of letter-sound associations and visual memorization, making word recognition challenging when distinguishing nuances in words with similar sounds and shape (e.g., 'train' and 'town') (Ehri, 2005).

The full alphabetic phase involves a deeper understanding of the alphabetic principle, where readers recognize and use letter-sound correspondences more consistently. Based on provincial curricula, by the end of Grade 3, children are expected to use knowledge of language patterns and phonics to decode words (BC Ministry of Education). At this stage phonology plays a crucial role in

enabling the child to form specific orthographic representations for words (Frith, 1985). Furthermore, children strengthen their ability to connect graphemes to word pronunciation and begin to decode unfamiliar words based on their phonetic knowledge. This concept is known as the bootstrapping hypothesis, suggesting that trying to decode unfamiliar words acts as a self-teaching mechanism, enabling the child to develop an orthographic representation for the word (Share, 1995). Imaging studies indicate that a distinct shift from right hemisphere to the left hemisphere activation during reading emerges around the age of eight (e.g., Grade 3)(Parviainen et al., 2006) suggesting less reliance on visual memory and more sophisticated activation in the typical neural network used by proficient readers.

At the more advanced consolidated alphabetic phase, readers have a solid grasp of the alphabetic system. They can efficiently decode words, and reading becomes more automatic. Word recognition improves, and readers can comprehend text more fluently. According to the BC curriculum, by the time students enter Grade 4 the focus of instruction shifts from learning phonics, decoding and fluency strategies to a focus on comprehension strategies in order “to deepen understanding of text” (BC Ministry of Education). This aligns with Ehri’s consolidated alphabetic phase which involves committing orthographic patterns to long-term memory, thereby reducing processing elements (e.g., working memory) in reading longer words. Readers transition to the consolidated alphabetic phase, after having thoroughly analyzed the spellings of numerous words stored in their lexical memory (Ehri, 2020). Consequently, they acquire an understanding of broader, consolidated spelling patterns that represent spoken syllables and morphemes. Ehri’s theory represents the progression in typical acquisition of reading skills and provides insights into the cognitive processes used during reading development. The consolidated alphabetic phase culminates in a process known as orthographic mapping (OM) whereby children make neural connections (Dehaene, 2009, pp 195-207) that link a word's appearance, sound, and meaning (Ehri, 2013, 2014). Participants in this study should have been

passing through these various stages during their acquisition of developmental reading skills. However, the disruptions caused by COVID may have altered the trajectory at which skills were consolidated, impacting students' abilities to achieve the expected grade-based performance set out in the BC curriculum. This research evaluates component readings skills against expected norms to determine which skills, if any, are potentially delayed and the proportion of students at risk for reading failure.

### **Component Reading Skills**

Component reading skills identified in the literature and emphasized in both the DIER model and Ehri's phase theory of reading development, as fundamental building blocks for proficient readers encompass several key aspects including a) vocabulary development, b) phonological awareness, c) decoding, d) word recognition and e) fluency (Ehri, 2020, 2005, Kim 2017, 2020, National Reading Panel, 2000). These component reading skills are interrelated and build upon each other to support reading development. Component reading skills were measured and tracked across both English and French Immersion participants to determine which skills were delayed and the proportion of students at risk for reading failure. Research suggests that learning to read in a second language involves the same component literacy skills laid out by the National Reading Panel (2000) (Erdos et, al, 2010). However, the rate at which these skills are acquired and the degree of proficiency in reading differs for French Immersion students (Geva & Clifton.,1994; Turnbull et, al. 2001, 2003). Immersion students typically perform comparably to that of their English-educated peers within two years of receiving English language instruction (Cashion, & Eagan, 1990; Geva & Clifton, 1994). The ability to match the academic level of students solely educated in English within 1 to 2 years indicates that competencies gained in French can be effectively transferred to English, and vice versa (Genesee, 2004; Turnbull et al., 2001, 2003). Considerable research findings indicate that early identification of children prone to word-based reading challenges in their second language is achievable through evaluations of their language and cognitive abilities in their first language. This assessment can occur before their proficiency in the

second language is fully established (Da Fontoura & Siegel, 1995; Geva & Clifton, 1994; Jared et al., 2011; MacCoubry et al., 2004). In general, the results indicate that evaluations of skills (i.e., phonological awareness, letter sound knowledge, rapid automatized naming, and grammatical ability) and knowledge related to the first language strongly predict later reading outcomes in the second language (Jared, et al., 2011). This provides solid evidence supporting the early identification of students in French immersion programs at risk for reading delays using English measures (Erdos et al., 2011; Jared, et al., 2011).

Irrespective of French Immersion or English instruction, effective reading instruction addresses the component reading skills by providing opportunities for practice and reinforcement to promote literacy proficiency. The inclusion of these component skills in both the DIER model and Ehri's Phase theory underscores their significance in the process of becoming a proficient reader (Ehri, 2020, 2005; Kim, 2017, 2020; National Reading Panel, 2000). These models are important to the proposed research as it provides insights into the fundamental building blocks for reading.

### ***Vocabulary***

Vocabulary is a well-documented and important predictor of reading comprehension (Baumann et al., 2003; Cain & Oakhill, 2014; Nagy, 2007) and was measured directly in the present study. Weak vocabulary skills represent a risk factor for later reading achievement. Likewise, prior research indicates that strong vocabulary is associated with later reading achievement (Cain et al., 2022, Moats, 2020) as children who have a strong vocabulary are better able to understand what they are reading. D'Angelo and Chen (2016) noted that poor vocabulary comprehension relates to weaknesses in both first and second language reading comprehension tasks for French immersion students. Vocabulary development is particularly important in the early years when children are building their foundational knowledge (Cain et al., 2022, National Early Literacy Panel, Lonigan et al., 2008, Moats, 2020; Perfetti & Hart, 2002). Vocabulary development begins at birth and by early elementary the level of word knowledge acquired

is an important predictor of future reading achievement (Cain et al., 2022, Moats, 2020). Measures that draw on a child's capacity to define words or to understand the links between words are more strongly associated with reading comprehension (Ouellette, 2006; Tannenbaum et al., 2006). Moreover, a robust vocabulary influences a student's capacity to tap into background knowledge, as delineated by the DIER model, with this information residing within long-term memory, as posited by information processing theory and aids in the facilitation of reading comprehension (Furqon, 2013). By possessing a rich lexicon, learners are better equipped to decode and comprehend texts, drawing upon their stored knowledge base to make connections and derive meaning from the material. This intricate interplay between vocabulary acquisition, background knowledge retrieval, and cognitive processing underscores the pivotal role language proficiency plays in fostering academic success and comprehension across various disciplines.

Although vocabulary facilitates reading comprehension there is an important cyclical relationship as reading exposes children to new words and consequently also builds vocabulary (Seidenberg, 2017). While direct instruction in developing and expanding children's oral language skills can build word knowledge, vocabulary development is ongoing throughout an individual's lifespan and not limited to early literacy instruction. Nevertheless, a rich vocabulary and the growing quality of a child's lexical representations, which are mental representations of words stored in long-term memory, plays a crucial role in reading comprehension. This aligns with the lexical quality hypothesis, proposed by Perfetti and Hart (2002), which posits the accuracy, richness, and organization of lexical representations significantly influence an individual's reading ability, making vocabulary a key variable to assess for participants in this research.

### ***Phonological Awareness***

Phonological awareness is one of the most critical factors for early reading development. This skill involves the smallest unit of speech and is necessary for sound symbol correspondence required for

learning to read and write (Mousinho & Correa, 2010; Capellini et al., 2011; Santos & Befi-Lopes, 2012). It refers to the ability to perceive and isolate speech sounds in order to segment and blend the sounds into words, syllables, and phonemes (Cárnio et al., 2017; Erdoğan & Erdoğan, 2010; Novaes, et al., 2013) which is essential in forming the association between spoken and written words and in facilitating the development of decoding (i.e., letter-sound relations) (Kilpatrick, 2015). Research has shown that children who have well-developed phonological awareness skills at the beginning of formal education are more likely to become successful readers (Bradley & Bryant, 1978, 1983; National Early Literacy Panel, Lonigan et al., 2008). Children with lower performance on phonological awareness assessments before commencing school face a higher risk of experiencing challenges in achieving effective reading proficiency compared to their counterparts who demonstrate higher scores in such assessments (Bradley & Bryant, 1978, 1983). Children with weak phonological awareness skills are more likely to struggle with decoding, which is a critical skill in learning to read (Torgesen, 2002). Over the years, an enormous amount of substantiating research has been devoted to phonemic awareness (which is a subskill of phonological awareness, the smallest unit of sound within words), confirming that phonemic skills are directly and positively correlated with reading comprehension (e.g., Cárnio et al., 2017; Capovilla & Dias, 2007; Mousinho & Correa, 2010; Navas et al., 2009; Rothou et al., 2013). Moreover, the transfer of English phonological awareness skills has been linked to learning to decode in early French immersion students and contributes to reading acquisition (e.g., Comeau et al, 1999; Jared et al, 2011; MacCoubrey et al 2004). Consequently, it is now generally accepted that phonological awareness skills are language general skills that demonstrate cross linguistic transfer (Bialystok, 2007; Savage et al. 2017). As phonological awareness is one of the most significant factors for early reading development, it was a fundamental skill to evaluate in this series of studies.

### ***Word Recognition***

Word Recognition involves the ability to go from serial decoding (i.e., letter by letter) to the

selection of a single word stored in lexical memory (Snow et al., 2005). This applies to previously read familiar words that are instantly recognized (Ehri, 2005) by an interplay between several lexical and semantic structures (Snowling & Hulme, 2005, p. 59). Over time, this process leads to a stockpile of phonographs (sound / symbol correspondence) and orthographic knowledge resulting in the efficient reading of known and unknown words (Dehaene, 2009, Jorm & Share, 1983; Share, 1999). More recently this process of instantly recognizing words and their meaning by permanently encoding it in memory for immediate recall has been termed “orthographic mapping” (Ehri, 2017; Sargiani, et al., 2018). Orthographic mapping involves, integrating a word’s visual representation (letters / graphemes), with its pronunciation (sounds / phonemes) and its meaning in long-term memory for immediate recognition (Perfetti, 1992; Rack et al., 1994). Studies have confirmed the importance of developing word recognition skills to facilitate reading comprehension (e.g., Cain et al., 2022; Leach et al., 2003), as such, word level reading was identified as a key metric to evaluate in this study.

### ***Decoding***

Decoding is another crucial factor that was measured throughout this longitudinal research. This skill refers to the capacity to apply letter sounds knowledge in order to read novel, single words, in isolation and involves knowledge of alphabetic principle and spelling-sound correspondences (Scarborough, 2001). It is best measured through non-word reading and is widely accepted as a foundational skill essential for reading comprehension (Gough & Tunmer, 1986; Hoover & Gough, 1990). Individual differences in decoding are strongly correlated with several component reading skills (Ehri, 2014), including phonological awareness (Hogan et al., 2005; Swank & Catts, 1994), decoding, (e.g., alphabetic principles; Backman et al., 1984), and sight word recognition (Aaron et al., 1999). A meta-analysis conducted by García and Cain, (2014), found decoding and reading comprehension are highly correlated. Predictably, elementary teachers focus on supporting students in consolidating the code as a cornerstone of instruction (McDonald Conner & McCardle, 2015, p.100; Ehri, 2014). Research suggests

that the use of systematic synthetic phonics instruction is an effective approach to teaching reading that systematically introduces learners to the relationships between sounds (phonemes) and the letters or letter groups (graphemes) that represent them in written language (Ehri, 2020). This method typically involves teaching phonics skills in a comprehensive and predetermined sequence, starting with the most basic letter-sound correspondences and gradually progressing to more complex phonetic patterns (Flanigan, et al., 2022; Mesmer & Griffith, 2005). The term "synthetic" refers to the process of synthesizing or blending individual sounds together to form words (Flanigan, et al., 2022). Systematic synthetic phonics instruction aims to provide learners with the foundational skills needed to decode words accurately and efficiently, ultimately fostering reading fluency and comprehension (Ehri, 2020; Mesmer & Griffith, 2005).

### ***Reading Fluency***

Reading Fluency is a crucial aspect of early reading development and was another key component of reading assessed in this series of studies. Over time, children consolidate the component reading skills with increasing automaticity (Hennessy & Moats, 2020). Reading fluency is the ability to accurately and quickly read words and or connected text (McDonald Conner & McCardle, 2015) and is considered a good predictor of reading comprehension (Fuchs et al., 2003; Kuhn & Stahl, 2003). Fluency is important because it frees up cognitive resources such as working memory, allowing children to focus on understanding what they are reading (National Institute of Child Health and Human Development, 2000) and represents a more advanced consolidated alphabetic phase (Ehri, 2020).

The aforementioned component reading skills acknowledged by the literature and highlighted in both the DIER model (Kim, 2020) and Ehri's (2020) phase theory of reading development, are essential building blocks for proficient readers. Early reading development is a complex process that involves many cognitive and linguistic factors. By developing foundational skills readers become increasingly more fluent and increasingly more strategic and thus more proficient comprehenders of text passages

(Hennessy & Moats, 2020). The proposed series of studies may shed light on the potential enduring impacts of significant interruptions in formal education, such as pandemics, climate disasters, war etcetera, on the evolving reading skills of primary students. By understanding the effects of educational disruptions on the progression of component reading skills, researchers may be able to ascertain and pinpoint pivotal junctures or transitions in a student's reading development. Being able to identify the particular delays in skill acquisition, alongside protective and risk factors, may empower educators to adopt a targeted approach to address lagging skills.

### **Resilience Theory: Risk and Protective Factors**

Resilience theory, may be viewed through a multisystem lens, providing a framework for understanding how risk and protective factors may contribute to primary students' recovery from the COVID-19 pandemic disruptions (Masten, 2020). Resilience has been conceptualized as an interaction between various systems—individuals, families, schools, and communities—that co-evolve and function interdependently to foster adaptation to adversity (Masten, 2014, 2020). For example, in the face of adversity, risk factors such as family instability or low SES, can be mitigated through consistent positive interactions with supportive relationships such as, connection with caregivers or teachers and broader systems like community programs or school interventions (Bronfenbrenner & Morris, 2006; Masten, 2014; 2020). Furthermore, the impact of stressful events may vary depending on a child's developmental stage or the timing of environmental stressors (Masten 2014, 2020). This is important to our study because participants were in Grade 1 when their education was disrupted at a critical phase in reading development (Ehri, 2020). Individual development is shaped through interaction between biological predispositions and environmental contexts (Bronfenbrenner & Morris, 2006; Masten, 2020; Ungar, 2011). In relation to recovery from CLL, phonological awareness and vocabulary function as both risk and protective factors (Carroll & Snowling, 2014; Stanovich, 1986), as they are influenced by both biological and environmental factors that influence reading development. Depending on the levels

present within an individual, or the degree of exposure to supportive experiences in their family, school, or community environment, these skills can either hinder or facilitate reading progress (Carroll & Snowling, 2014).

Other risk/protective factors include SES, attendance, and cultural and linguistic diversity. These risk factors have been shown to exacerbate academic disparities and contribute to SLL (Alexander et al., 2007). Consequently, these factors along with SLL were considered important variables when examining the impacts of CLL. Children from lower socioeconomic status (SES) backgrounds often have reduced access to early literacy experiences, such as books, reading activities, and rich language exposure at home, which are essential for developing foundational reading skills (Snowling & Hulme, 2012). Low-SES families may face higher levels of stress and less access to quality early childhood education, which further exacerbates reading delays (Hart & Risley, 1995). School attendance also plays a key role in reading development. Chronic absenteeism leads to missed opportunities for structured literacy instruction, reducing the time children spend practicing and developing critical reading skills (Gottfried, 2010). Additionally, cultural and linguistic diversity can sometimes result in reading delays when children are not provided with appropriate support for acquiring literacy skills in a second language, or when there is a mismatch between home and school language environments (August & Shanahan, 2006). Students at risk for reading delays often face multiple, overlapping challenges related to SES, vocabulary and PA skills, cultural and linguistic diversity, and insufficient educational support. These challenges combined with the pandemic's cascading effects, such as school closures and social isolation, disrupted multiple systems essential to child development, requiring resilience not only at the individual level but also within broader social and institutional networks (Masten, 2020).

**Chapter III: Study 1**

**Impacts of COVID-19 Education Disruptions on Early Reading Development**

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### Abstract

Children who have not developed proficient reading skills by Grade 4 tend to struggle across subject areas in Grade 8 and often continue to experience lifelong reading challenges (National Early Literacy Panel, Lonigan et al., 2008; Ritchey et al., 2013). Not surprisingly, reading achievement and the impacts of COVID learning loss (CLL) have been widely investigated in recent years. However, there exists a notable void in the literature regarding the long-term ramifications of educational disruptions on the developmental trajectory and acquisition of foundational reading skills. This study focuses on a cohort of 214 students who were in Grade 1 during the pandemic school closures in the spring of 2020 and were evaluated one year following the return of regular instruction in the fall 2021. Findings indicate that students had not spontaneously recovered from CLL when evaluated against expected reading norms, with a significant proportion (74%) performing within the at-risk range in one or more foundational reading skills, encompassing vocabulary, phonological awareness, word level reading, decoding, and fluency. Moreover, students performed as poorly as children who had no formal English instruction (i.e., French Immersion students) suggesting that school closures exponentially impacted reading development and produced an enduring floor effect. The results suggest caution in the identification of students with reading disabilities during this time (e.g., NASP, 2020) and highlight the role that vocabulary, phonological processing and SES served in reducing the impact of educational disruptions on the development of early reading skills. The findings also raise questions about the potential long-term consequences that gaps in the development of foundational reading skills may have on student's future academic achievement.

*Keywords:* reading development, component literacy skills, COVID learning loss, educational disruptions, direct and indirect effects of reading model (DIER), phase theory of reading development

## Introduction

### Impacts of COVID-19 Education Disruptions on Early Reading Development

Studies indicate that children who have not acquired proficient reading abilities by the fourth grade often encounter difficulties across various academic disciplines by the time they reach eighth grade, and these challenges often persist into adulthood (National Early Literacy Panel, Lonigan et al., 2008; Ritchey et al., 2013), making disruptions to learning in their primary years concerning. In March of 2020, schools around the world were forced to close their doors due to the global pandemic caused by the rapid spread of the COVID-19 virus. Disruptions to education such as this have been shown to be detrimental to short-term and long-term academic outcomes (e.g., Atteberry & McEachin, 2021; Cooper et al., 1996). Large-scale societal events like World War II (Ichino & Winter-Ebmer, 2004), the polio pandemic (Meyers & Thomasson, 2020), the great depression as well as more localized recent events like Hurricane Katrina, the 2008 recession and prolonged teachers' strikes (Belot & Webbink, 2010) have been shown to shift the trajectory of students' normative development (Almeida & Wong, 2009; Benner & Mistry, 2020). Furthermore, the research on summer learning loss (SLL) is another powerful indicator of how regular disruptions to education impact students' long-term academic outcomes (Alexander et al., 2007; Atteberry & McEachin, 2020). Findings from Hammerstein et al. (2021) indicate that the reported learning effects during COVID were comparable to SLL findings ( $d = -0.005$  SD to  $-0.05$  SD) per week. Importantly, researchers Aurini and Davies (2021) noted that *"at some unknown threshold of non-school time beyond a standard summer vacation, learning losses may become non-linear and more extreme, accelerating the atrophy of skills, particularly among struggling students"* (p. 180), further raising concerns about the long-term effects of disruptions to education on students learning.

For many students, the return to regular in-person instruction post-pandemic lockdowns did not fully resume until the following September, representing as much as a six-month instructional gap. Moreover, for many primary grade students, the move to online learning in March of 2020 was

ineffectual (Hammerstein et al., 2021; Tomasik et al., 2021). Two years into the pandemic, many students were still experiencing periodic educational disruptions as classrooms and schools were forced to quarantine or isolate due to virus outbreaks. The consequences of such disruptions are especially concerning for students in younger grades who were at developmentally critical periods in their learning.

### **COVID-19 Learning Loss**

Some of the early COVID-19 learning loss predictions based on summer learning loss research estimated that students would start the 2020 school year with only 63-68% of learning gains compared to previous years (Kuhfeld et al., 2020). The preliminary data was mixed, with some studies indicating minimal short-term impacts on academic growth during lockdown, (Förster et al., 2022; Kuhfeld et al., 2020) particularly for students in higher grades (Tomasik et al., 2021), while other studies revealed significant learning loss (e.g., Maldonado & De Witte, 2021). Early evidence indicated that the educational disruptions caused by the pandemic had a significant impact on students' math achievement, with seemingly little effect on reading scores for students who had already acquired basic reading skills (e.g. Grade 3-8) (Kuhfeld et al., 2020). However, the implications may be more concerning when the acquisition of foundational reading skills are interrupted, as would be the case for younger students in earlier grades. There is a growing body of research suggesting that reading development was also negatively impacted (immediately) following the pandemic compared to pre-pandemic cohorts (Aurini & Davies, 2021; Engzell et al., 2021; Hammerstein et al., 2021; Kogan & Lavertu, 2021; Lerkkanen et al., 2023; Relyea et al., 2023; Tomasik et al. 2021).

When reading scores of students affected by the pandemic were compared with a pre-COVID sample from 2008-2011, it was found that reading skills on average were lower in the COVID sample than in the pre-COVID sample (Lerkkanen et al., 2023). Similarly, Engzell et al. (2021) demonstrated a significant deterioration in test scores among students during the pandemic. Likewise, research on

Grade 3 students in Ohio revealed a substantial decline in English language arts scores at the onset of the 2020 school year, indicating a significant setback of 0.23 standard deviations compared to their pre-pandemic peers assessed in Fall 2019 (Kogan & Lavertu, 2021). Further examining the dynamics of CLL Tomasik et al. (2021) compared pre-pandemic learning gains across reading, grammar, and math with learning during lockdown among 28,685 students and found that primary students exhibited significantly higher mean learning slopes with in-person learning compared to distance learning during the pandemic. Specifically, primary students' learning slope was more than double before lockdown compared to during remote learning. Interestingly, for secondary students, there was no significant difference in learning slopes between in-person and remote learning, suggesting that younger students face greater challenges in adapting to remote learning environments and may struggle to sustain long-term learning gains compared to older students (Tomasik et al., 2021). Moreover, research investigating reading development in Grade 3-5 students highlighted that the pandemic cohort displayed lower reading gains compared to their pre-pandemic counterparts, indicating substantial learning losses (Relyea et al., 2023). The authors emphasized that school closures, stemming from the pandemic, had a particularly pronounced impact on students in the early stages of reading development, emphasizing their heightened need for instructional support during these disruptions (Relyea et al., 2023).

In 2022, the United States National Center for Education Statistics undertook a unique administration of the National Assessment of Educational Progress (NAEP) long-term trend assessments in reading and mathematics for 9-year-old students to assess their academic performance during the COVID-19 pandemic. This cohort of students is similar to our study participants in that the majority would have been in Grade 1 during the 2019/2020 school year when the pandemic caused extended school closures and disruptions to their learning. The NAEP results revealed a statistically significant ( $p < .05$ ) decrease in average scores for reading when compared to 2020. The report further notes that this decline marks the most significant drop in average reading scores since 1990 (U.S. Department of

Education, Institute of Education Sciences, National Center for Education Statistics, n.d.). Despite this growing body of research, and evidence indicating significant learning loss for primary students, relatively little is understood about the long-term effects of CLL and the manner in which the disruptions altered the developmental trajectory and acquisition of foundational reading skills. The NAEP data helps build a compelling case for the importance of studying reading loss in students who were in Grade 1 during the pandemic lockdowns.

### **The Current Study**

The current study is phase one of a longitudinal project that examined the developmental trajectory of reading ability in students who had their learning disrupted because of the COVID-19 pandemic. The goal of the current study was to investigate component literacy skills (e.g., phonological awareness, decoding, fluency, etc.) in order to a) identify any gaps in students' reading ability, b) establish baseline reading achievement scores, c) determine the proportion of students falling in the at-risk range on one or more component reading measures, d) investigate whether factors such as income level or program of instruction (i.e., French Immersion or English) resulted in different reading outcomes and, e) provide School Districts a means to plan appropriately for students' needs as we move beyond the pandemic.

This research explores component reading skills associated with Linnea Ehri's (2005) Phase Theory of Reading Development which outlines four key developmental stages in learning to read words. In the initial pre-alphabetic phase (kindergarten age), readers rely on visual features and without a strong connection to letter-sound relationships. They might recognize words based on visual cues and context but are not yet connecting phonemes (speech sounds) to graphemes (letter representations). During the partial alphabetic stage (Grade 1-2), readers start associating letters with specific sounds but may not fully understand the alphabetic principle. The full alphabetic stage (Grade 3-4) involves a deeper understanding of the alphabetic principle, where readers recognize and use phonemes -

graphemes (letter-sound) correspondences more consistently. They begin to decode unfamiliar words based on their phonetic knowledge and recognition of orthographic patterns. In the advanced consolidated alphabetic stage (Grade 4 and up), readers have a solid grasp of the alphabetic system. They can efficiently decode words, and reading becomes more automatic. Word recognition improves, and readers can comprehend text more fluently. Ehri's developmental phases highlight distinctions in how children engage with the alphabetic code, forming connections between a word's visual appearance, its auditory (phonological) representation, and its meaning (i.e., orthographic mapping; Ehri, 2005, 2020). This framework informs the conceptualization and measurement of word level component reading skills in this study including a) vocabulary, b) phonological awareness, c) letter and word recognition, d) decoding, e) word reading fluency, and f), decoding fluency.

This study set out to examine whether students were achieving below expectations on component skills based on standardized achievement measures and pre-pandemic population norms. Our research is unique as students in Grade 1 would usually be assessed for reading at the end of the school year after having time to consolidate foundational skills. Due to pandemic related school closures, these assessments were unable to take place in many school jurisdictions. Therefore, no comparative baseline data exists. To address this challenge, we used norm-referenced assessments to compare current reading achievement with predicted levels based on a typical developmental trajectory and a normal distribution. We set out to determine what proportion of Grade 3 students, who were in Grade 1 when COVID-19 lockdowns began, were falling below expectations on component literacy skills based on standardized norm referenced measures (and whether the proportion falling below expectation exceeded historically documented levels preceding the pandemic).

In addition, the study explores whether students from low SES backgrounds were falling even further behind their more affluent peers and to what extent students from French Immersion programs were performing below their English peers on English reading measures. Comparison of students in

French immersion and English programs was investigated to provide our partner school district a broad picture of how educational disruptions were impacting Grade 3 students in parallel programs. Research supports early identification of second language (L2) learners prone to reading challenges through assessments of their first language (L1) abilities (Da Fontoura & Siegel, 1995; Geva & Clifton, 1994; Jared et al., 2011; MacCoubry et al., 2004), with L1 evaluations strongly predicting later L2 reading outcomes (Jared et al., 2011). It was hypothesized that a greater proportion of the students would have reading deficits than pre-pandemic population norms and that those from lower SES backgrounds would be more significantly impacted than their more affluent peers. In light of the fact that French Immersion students only tend to perform comparably to that of their English-educated peers after receiving formal English instruction (Cashion, & Eagan, 1990; Geva & Clifton, 1994), it was further hypothesized that French Immersion students would perform significantly below their English peers on the English reading measure (as formal English reading instruction had yet to be introduced). These variables were of particular interest as SES is a known predictor of academic performance, and language of instruction can create unique learning environments that may differentially impact literacy development.

## **Methods**

### **Participants**

Given the evidence from summer learning loss research suggesting that the summer between Grade 1 and 2 represents the largest and most significant loss (Atteberry & McEachin, 2020; Slade et al., 2017), this project focuses on those students who were enrolled in Grade 1 in March of 2020 when COVID-19 restrictions began. This cohort of students started their spring break on March 7<sup>th</sup>, 2020, and did not resume regular face to face instruction until September 8<sup>th</sup>, 2020. Despite best efforts to engage students in online learning, these students had what amounts to a six-month extended summer break at a time when reading skills were in their infancy. These students entered Grade 3 in September 2021 at the start of phase one data collection. A total of 214 Grade 3 children across five elementary schools

(three English and two French immersion), were included in the first wave of data collection for this longitudinal study. The French immersion students were all native English speakers whose formal literacy instruction was strictly in French. Our partner school district in British Columbia, Canada, was the curator of the data and released anonymized secondary data to the researcher following university institutional research ethics approval. As such, no formal recruitment was required. There were no exclusion criteria - all students who were enrolled in Grade 3 at participating schools were included in the study. Table 1 outlines the demographic breakdown of participants in wave one of the study. The breakdown of students is similar to the norm-referenced group. For example, three students with special education designations were diagnosed with an intellectual disability representing 1.4% of the sample. Similarly, 1.4% of the normative sample for the Kaufman Test of Educational Achievement (KTEA-3) were identified as having an intellectual disability (Kaufman et al., 2014 p. 33).

**Table 1**

*Sample Characteristics*

Demographic	Total	Male	Female
Number of Participants	214	104	110
English	120	66	54
French Immersion	94	38	56
Special Education Designation	13	8	5
Indigenous Heritage	25	11	14
English Language Learners (ELL) <sup>a</sup>	6	3	3
Mean Age in Months	99.36	99.20	99.51

*Note.* <sup>a</sup>ELL students who are not also Indigenous.

**Measures**

In keeping with the literature, we focused on component reading skills most frequently used in early screening batteries including word reading, phonological awareness, decoding, and fluency (Jenkinson et al., 2007), as these are the required building blocks for the development of efficient reading comprehension (McKenna & Stahl, 2009; Scarborough, 2001). These measures include selected subtests from the Canadian Edition of the Wechsler Intelligence Scale for Children Fifth Edition (WISC-V;

Wechsler, 2015), Kaufman Test of Educational Achievement, third edition (KTEA-3; Kaufman & Kaufman, 2014), and the Comprehensive Test of Phonological Processing - Second Edition (CTOPP – 2; Wagner et al., 2013). Each of these norm-referenced standardized tests yield measures with a standard score mean of 100 and a standard deviation of 15. Standard scores from these measures are derived by comparing student's raw scores to those obtained by a large norm group of similar-aged children. In line with previous research, we classified students' performance on specific reading components as at-risk if their scores fell within the lowest 25th percentile (Lindsey et al., 2003; Wise et al., 2007). According to pre-pandemic population norms for these well-established norm-referenced standardized measures, 25% of students would be expected to achieve results in the first quartile, falling at or below a Standard Score of 90 (Guilmette et al., 2020) with the remaining 75% meeting grade-level expectations.

### ***Vocabulary***

The WISC-V Vocabulary subtest was used to gauge student's word knowledge and verbal concept formation. This subtest also measures crystallized intelligence, fund of knowledge, and degree of vocabulary development. Children were presented a word orally and were asked to provide a verbal definition of the target word. The split-half reliability coefficient for the vocabulary subtest is reported at .87. The test manual reports adequate content, construct, and criterion-relation validity (Wechsler, 2015).

### ***Phonological Awareness***

The CTOPP-2 Elision subtest was used to assess students' phonological awareness (PA) skills. This subtest requires participants to say the word that remains after deleting syllables (early items) or phonemes (later items) (e.g., *"Say basketball. Now say basketball without saying basket."* Or *"Say sprain. Now say sprain without saying 'r'."*). The coefficient alpha as a measure of internal consistency is reported as .91. The test manual reports adequate content, construct, and criterion-relation validity (Wagner et al., 2013).

***Word Level Reading***

English word level reading accuracy was assessed using the KTEA-3 Letter Word Recognition subtest, which measure the ability to identify letters and read both regular and irregular words. Regular words are those that are read correctly by applying grapho-phonemic principles, and irregular words are those words that can be read correctly only if the student is familiar with the word. The students were given a list of words of increasing difficulty to read aloud. The test manual reports adequate content, construct, and criterion-related validity. The split half reliability coefficient for letter word recognition has a mean of .97 for Grades K-12 (Kaufman & Kaufman, 2014).

***Decoding***

The KTEA-3 Nonsense Word Decoding subtest was used to measure the ability to apply letter-sound skills to decode nonwords. The test manual reports adequate content, construct, and criterion-related validity. The split-half reliability coefficient for nonsense word decoding has a mean of .96 for Grades K-12 (Kaufman & Kaufman, 2014).

***Word Reading Fluency***

The KTEA-3 Word Reading Fluency task was used to measure reading fluency. This timed subtest requires children to quickly and accurately read a list of words during two 15-second trials. The test manual reports adequate content, construct, and criterion-related validity. The reliability coefficient for Word recognition fluency has a mean of .86 for Grades K-12 (Kaufman & Kaufman, 2014).

***Decoding Fluency***

The KTEA 3 Decoding Fluency task assessed children's speed and accuracy in applying letter-sound skills to decode nonwords during two 15-second trials. The test manual reports adequate content, construct, and criterion-related validity. The coefficient for decoding fluency has a mean of .82 for Grades K-12 (Kaufman & Kaufman, 2014).

**Procedures**

The students were assessed individually in a quiet setting (e.g., learning assistance room, library) at their elementary school. Raw data for the English reading and Vocabulary measures were collected through iPad administration and entered into the partner school district's online assessment platform. For the PA measures, we used the customary paper and pencil standardized administration procedures established by the test developers. Starting points and discontinuation rules were followed for each measure in accordance with their respective test manuals. Raw scores and standard scores were recorded for each measure. The school district released the secondary anonymized raw scores and derived standard scores for analysis. In addition, they provided existing anonymized demographic information (e.g., gender, ethnicity, special education designation, program enrolment etc.) linked to neighborhood-aggregated census data indicating SES.

***Statistical Procedures***

Multilevel modelling (MLM) was used for cross-sectional analysis of wave one data to investigate whether students across five schools were meeting age expectations on key component reading skills (e.g., phonological awareness, word reading, decoding, reading fluency) and to explore whether SES and program of instruction (English vs. French Immersion) were associated with different reading outcomes. MLM was chosen because it appropriately accounts for the hierarchical structure of the data, with students nested within schools, and controls for the non-independence of observations within these groups. In studies where observation of the phenomenon and post-hoc analyses are required, MLM is important in order to account for higher-level groupings of subjects into clusters (i.e., students within schools or instructional programs). It cannot be assumed that the observations at the student level are independent of their higher-level clustering within schools or instructional program and there is a need to account for this nestedness in order to derive accurate standard error estimates and corresponding tests of significance (Singer & Willet, 2003). By using MLM, the study was able to

assess the extent to which reading skills varied between students and across schools while examining whether differences in reading outcomes were influenced by SES or instructional context. In particular, using a multilevel approach allows us to examine student level influences that are not confounded with school level factors.

## Results

For all norm-referenced measures, we would expect a mean of 100 and a standard deviation of 15. Our phase one preliminary results indicate a normal distribution of WISC-V Vocabulary scores with a standard score mean of 100.62 and a standard deviation of 14.8, suggesting normally distributed ability and learning potential. Means and standard deviations for each measure are shown in Table 2, as well as the proportion of students falling in the bottom quartile. In an otherwise typical (i.e., non-pandemic) instructional environment, we would predict approximately 25% of students to score in the bottom quartile and thus be at-risk for reading delays (Guilmette et al., 2020). There were no statistically significant differences across the measures between children in the English or French programs. As the complexity of reading skill increases, the overall mean score decreased. For the reading measures, we found that double the expected number of students fell in the at-risk range on word reading, with an even greater proportion exhibiting challenges with decoding (See Table 2). Similar results were obtained for word reading fluency and decoding fluency measures. Together, these findings indicate that 74% of students were not meeting expected reading outcomes in one or more foundational literacy skill and require some form of targeted intervention.

**Table 2**  
*Descriptive Statistics for Component Reading Skills*

Measures	English					French Immersion				
	Mean <sup>a</sup>	SD	Min	Max	Prop. at Risk <sup>b</sup>	Mean <sup>a</sup>	SD	Min	Max	Prop. at Risk <sup>b</sup>
Vocab.	100.62	14.79	65	130	17%	103.04	13.98	65	130	15%
PA	90.27	13.32	55	125	52%	89.34	12.60	55	120	57%
WR	88.81	17.99	45	128	50%	85.63	19.87	45	128	55%
Decoding	85.99	14.42	63	125	62%	83.06	14.20	63	118	65%
WR Fluency	84.73	18.34	39	131	62%	81.76	19.55	39	131	64%
Dec Fluency	81.22	20.68	39	128	63%	77.90	21.27	39	128	66%

*Note.* <sup>a</sup>Norm Referenced Standard Score Mean=100; Standard Deviation=15. <sup>b</sup>Scoring  $\leq 25^{\text{th}}$  Percentile; Vocab. = WISC-V Vocabulary; PA = Phonological Awareness (CTOPP Elision); WR = Word Reading (KTEA-3 Letter and Word Recognition); Decoding (Nonsense Word Decoding(KTEA-3); WR Fluency = Word Reading Fluency (KTEA-3); Dec. Fluency = Decoding Fluency (KTEA-3).

### **Multilevel Analysis of Reading Outcomes**

To examine within (student-level) and between (school-level) sources of variance in the reading outcomes, we first fit fully unconditioned multilevel models for each reading outcome variable including word reading, decoding, word reading fluency, and decoding fluency. Vocabulary and Phonological Awareness measures were used as predictor variables in subsequent models. At the micro level, each student's reading scores were modelled as a function of the average performance for their school plus any residual variance. At the macro level, the performance mean for each school (on each reading outcome variable) was modeled as a function of the grand mean performance across the entire sample (i.e., all five schools).

**Level 1 Equation:**  $Y_{ij} = B_{0j} + \epsilon_{ij}$

**Level 2 Equation:**  $B_{0j} = \gamma_{00} + u_{0j}$

The unconditional multilevel models revealed significant variability across students, within schools, in reading achievement measures, suggesting that it would be worthwhile to examine a conditional model with level-1 predictors aimed at explaining some of this variance. Table 4 summarizes the variance components associated with the fixed and random effects. The intraclass correlation coefficient (ICC) represents the percentage of total variance that is between level-2 units. The results suggest that comparatively more variance exists at the student level, with only 4 to 7 % of the total variation remaining to be explained at the second (i.e., between-school) level. The design effect was calculated to quantify the magnitude of independence violations on standard errors in order to correct for the negative bias that results from nested data (Peugh, 2010). The design effect for each reading outcome shown in Table 3 is greater than 2 across all variables, thereby justifying the use of multilevel modelling (Muthén, 1991, 1994; Muthén & Satorra, 1989, 1995).

**Table 4**  
*Unconditioned Multilevel Models for Outcome Reading Variables*

<i>Effect</i>	Word Reading	Decoding	WR Fluency	Decoding Fluency
<b>Fixed Effects</b>				
Intercept ( $\gamma_{00}$ )	88.95	86.05	84.86	81.41
<b>Random Effects</b>				
Within-School Variance ( $\sigma^2$ )	299.70***	192.90***	318.51***	394.17***
Between School Variance ( $\tau_{00}$ )	20.88	13.09	15.43	29.42
ICC = $\tau_{00} / (\tau_{00} + \sigma^2)$	0.07	0.06	0.05	0.07
<b>Design Effect</b> = $1+(nc-1)$ ICC	3.93	3.51	2.09	3.93
-2 Log Likelihood	1834.56	1740.17	1846.3	1893.46

Note. \* $p < .05$       \*\*\* $p < .001$

**Student-Level Predictors of Component Reading Skills**

**Student-Level Vocabulary and PA as Predictors.** Component reading performance for each reading outcome variable (Y) was modelled as a function of the mean performance for each school ( $B_{0j}$ : the intercept), plus a slope parameter ( $B_{1j}$ ) reflecting the impact of student vocabulary ( $Vocab_{ij}$ ) and PA ( $PA_{ij}$ ) relative to the school average on each reading achievement measure (per unit of increase in Vocabulary & PA), plus an error term ( $\epsilon_{ij}$ ) reflecting within-subject residual variance remaining to be explained. With group-mean centering, the vocabulary score for each student is subtracted by the school vocabulary mean (i.e.,  $X_{ij} - \bar{X}_j$ ) or ( $Vocab_{ij} - \overline{Vocab_j}$ ). Likewise, the PA score for each student is subtracted by the school PA mean ( $\overline{PA_j} - PA_j$ ). Group-mean centering facilitates the examination of student-level associations between predictor variables (i.e., Vocab and PA) and component reading outcome variables that are unconfounded by school-level influences.

**Level 1 Equation:**       $Y_{ij} = B_{0j} + B_{1j}(Vocab_{ij} - \overline{Vocab_j}) + \epsilon_{ij}$

**Level 2 Equations:**       $B_{0j} = \gamma_{00} + u_{0j}$

$B_{1j} = \gamma_{10} + u_{1j}$

The level-one intercepts for each reading outcome variable ( $B_{0j}$ : average, achievement for each school, j) were modelled as a function of the population average intercept ( $\gamma_{00}$ ) across schools for student vocabulary and again for PA plus the residual variance about sample estimates ( $u_{0j}$ : School

specific deviations from the average) remaining to be explained. The level-one slopes ( $B_{1j}$ : the impact of students' vocabulary and PA on reading achievement) for a given school are modelled as a function of the population average slope ( $\gamma_{10}$ ) across schools per unit increment in vocabulary and PA scores, plus the residual variance ( $u_{1j}$ : school specific deviations from the average) remaining to be explained.

Table 4 indicates that centered vocabulary and PA were statistically significant predictors of reading achievement across all component reading skills. For every standard score increase in vocabulary, there was a 0.58 standard score increase in word reading, a 0.42 standard score increase in decoding, a 0.57 standard score increase in word reading fluency, and a 0.62 standard score increase in decoding fluency (all  $p$ s < .001 see Figure 2). Similarly, for every standard score increase in PA, there was a 0.70 standard score increase in word reading, a 0.67 standard score increase in decoding, a 0.74 standard score increase in word reading fluency, and a 0.94 standard score increase in decoding fluency (all  $p$ s < .05; see Figure 3). The unconditioned model provides a benchmark for how much Level 1 and 2 variance is subsequently accounted for when entering predictor variables. The models that included vocabulary and PA as predictors explained significantly more variance than did the unconditioned models that included only the within-school residuals and between-school variances. Specifically, we computed a measure of effect size (pseudo  $R^2$ ) by deriving the amount of student-level variance accounted for by including vocabulary and PA as level-1 predictors. Student-level differences in vocabulary accounted for 23.44% of the variance in Word Reading, 18.72% in Decoding, 20.33% in Word Reading Fluency, and 19.78% in Decoding Fluency. For each reading outcome variable, the change in -2 restricted log likelihood was significant at the  $p = < .001$  level, with the word reading variable representing the biggest change. Likewise, Student-level differences in PA accounted for 27.05% of the variance in Word Reading, 37.84% in Decoding, 28.38% in Word Reading Fluency, and 36.35% in Decoding Fluency. For each reading outcome variable, the change in -2 restricted log likelihood was significant at the  $p = < .001$  level.

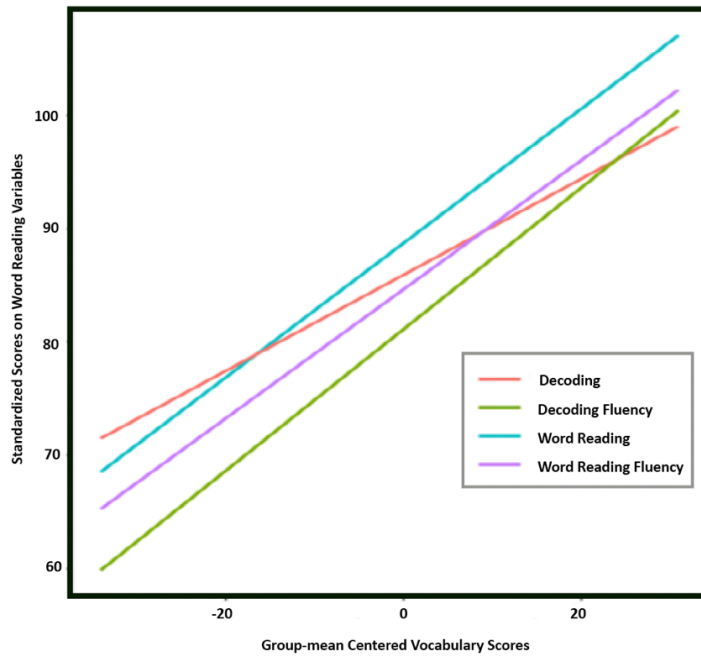
**Table 5***Effects of Vocabulary and Phonological Awareness on Component Reading Skills*

<i>Reading Skills</i>	<i>Vocabulary</i>			<i>Phonological Awareness</i>		
	<i>Estimate</i>	<i>SE</i>	<i>95% CI</i>	<i>Estimate</i>	<i>SE</i>	<i>95% CI</i>
<b>Word Reading</b>						
Fixed Effects						
Intercept $\gamma_{00}$	88.81***	2.35	84.21-93.42	88.93***	2.36	84.30-93.55
Slope $\gamma_{10}$	0.59***	0.07	0.45-0.74	0.70***	0.08	0.55-0.86
Random Effects						
Within-School Differences	229.46***		189.45-277.93	218.63***		180.50-264.78
Between-School Differences	21.75	-	4.76-99.34	22.25	-	4.96-99.70
<b>Decoding</b>						
Fixed Effects						
Intercept $\gamma_{00}$	85.95***	1.88	82.25-89.64	86.03***	1.87	82.37-89.68
Slope $\gamma_{10}$	0.42***	.06	0.30-0.54	0.67***	0.06	0.55-0.78
Random Effects						
Within-School Differences	156.78***		129.44-189.89	119.90***		99.03-145.25
Between-School Differences	13.80	-	2.94-64.71	14.33	-	3.12-61.98
<b>Word Reading Fluency</b>						
Fixed Effects						
Intercept $\gamma_{00}$	84.75***	2.12	80.57-88.90	84.84***	2.13	80.66-89.02
Slope $\gamma_{10}$	0.57***	0.08	0.41-0.72	0.74***	0.08	0.58-0.90
Random Effects						
Within-School Differences	253.75***	-	209.51-307.34	228.13***		188.35-276.32
Between-School Differences	16.24	-	3.10-85.01	16.99	-	3.44-83.94
<b>Decoding Fluency</b>						
Fixed Effects						
Intercept $\gamma_{00}$	81.26***	2.77	75.83-86.70	81.39***	2.78	75.95-86.82
Slope $\gamma_{10}$	0.62***	.09	0.45-0.79	0.94***	0.09	0.77-1.10
Random Effects						
Within-School Differences	316.19***	-	261.05-382.97	250.87***		201.07-303.87
Between-School Differences	30.43	-	6.68-138.63	31.96	-	7.51-135.96

Note. \* $p < .05$ \*\*\* $p < .001$

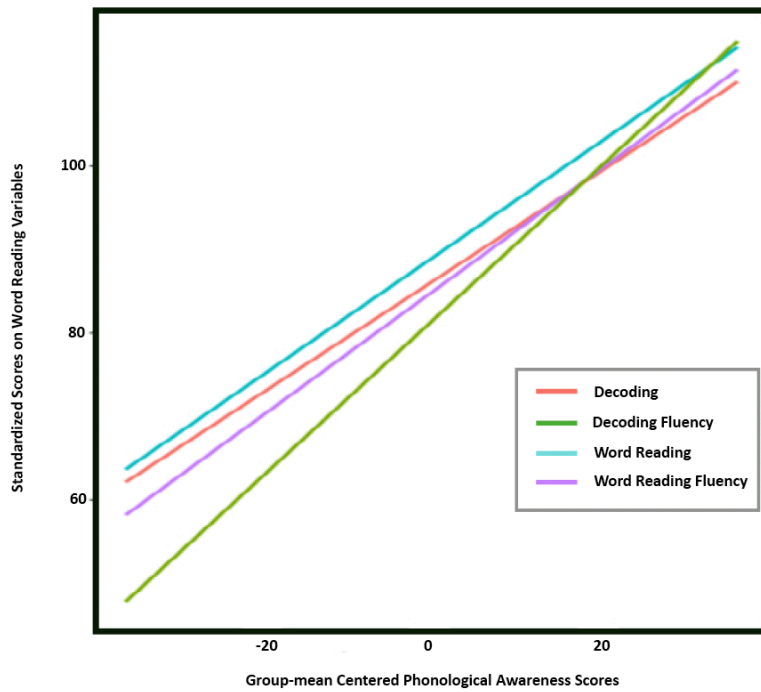
**Figure 2**

*Association Between Component Reading Skills and Vocabulary*



**Figure 3**

*Association Between Component Reading Skills and Phonological Awareness*



**Multivariable Prediction Model:** Because word reading conceptually is foundational, and because the other variables are progressively more difficult, the word reading variable was chosen to analyze the effects of SES on reading. This model included word reading as the outcome variable and two level one predictors with group mean centered vocabulary and group mean centered student level SES. With group mean centering, the predictor variable scores (i.e., vocabulary and SES) for each student is subtracted by the school mean for that variable (i.e.,  $X_{ij} - \bar{X}_j$ ). In this model we also added several level-two predictors including program type, (i.e., French Immersion or English), grand mean centered school-level SES and their interactions. In grand mean centering, the total sample mean SES is subtracted from each students' SES score (i.e.,  $X_{ij} - \bar{X}$ ). The results of this model are presented in table 5.

#### Level-1 Model

$$Y_{ij} = B_{0j} + B_{1j}*(Vocab_{ij} - \overline{Vocab_j}) + B_{2j}*(SES_{ij} - \overline{SES_j}) + \varepsilon_{ij}$$

#### Level-2 Models

$$B_{0j} = \gamma_{00} + \gamma_{01}*(School) + \gamma_{02}*(SES\_GM) + \gamma_{03}*(SchoolXSES\_GM)$$

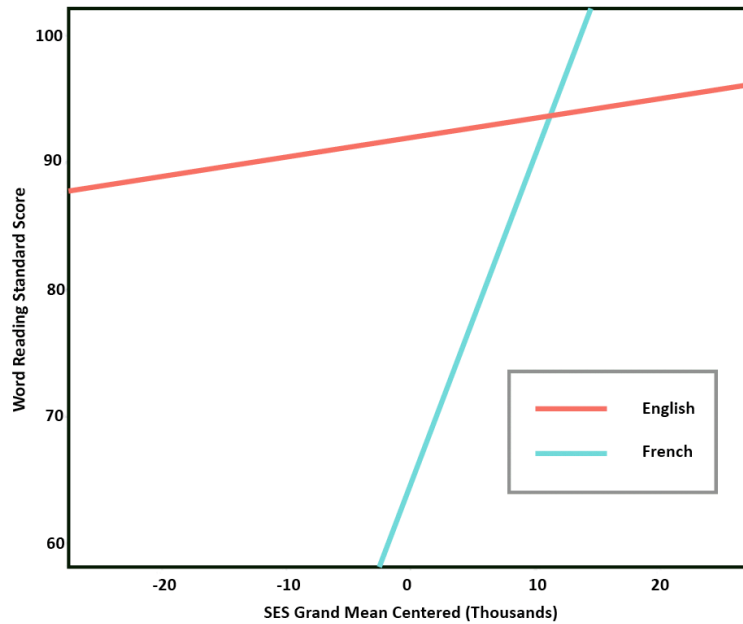
$$B_{1j} = \gamma_{10} + \gamma_{11}*(School) + \gamma_{12}*(SES\_GM)$$

$$B_{2j} = \gamma_{20} + \gamma_{21}*(School)$$

The intercept ( $\gamma_{00}$ ) represents average word reading scores for French schools with typical student-level SES. Table 5 shows that English schools ( $\gamma_{01}$ ) are 27.37 standard score points higher on word reading relative to French schools for the average level of student SES ( $\gamma_{02}$ ) within a given school. The interaction between program type and school level SES ( $\gamma_{03}$ ) was significant, indicating that the predictive impact of school level SES on word reading significantly varied between the French schools in comparison to English schools (see Figure 4).

**Figure 4**

*Comparison of SES Influence on Word Reading*



*Note.* This plot shows the interaction between program type (0 = French; 1 = English) and SES (0 = the grand mean of \$95,000, and the other values reflecting +/- \$10000 at a time).

**Table 6**

*Effects of SES and Program Type (English vs. French) on Word Reading Skills*

<i>Effect</i>	<i>Estimate</i>	<i>SE</i>	<i>T-Statistic</i>	<i>P-Value</i>
<b>Intercept, B0</b>				
Intercept $\gamma_{00}$	64.60	5.12	12.62	.000
School $\gamma_{01}$	27.37	5.38	5.09	.015
SES GM $\gamma_{02}$	0.003	0.001	4.35	.000
School X SES $\gamma_{03}$	-0.002	0.001	- 3.94	.000
<b>VOCAB Slope, B1</b>				
Slope $\gamma_{10}$	0.69	0.12	5.76	.000
School $\gamma_{11}$	-0.155	0.155	-1.00	.317
SES GM $\gamma_{12}$	0.000	0.000	0.185	.853
<b>CSES Slope, B2</b>				
Slope $\gamma_{20}$	-0.003	0.001	-4.254	.000
School $\gamma_{21}$	0.002	0.001	3.834	.000

## Discussion

Although a growing body of evidence indicates that students' reading skills have been negatively affected by COVID-related learning loss (CLL), the specific ways in which these disruptions impacted reading development, and the acquisition of foundational skills are still not well understood. Our study aimed to investigate CLL and whether students were attaining proficiency levels below the established expectations on foundational component reading skills as determined by standardized achievement assessments and pre-pandemic age-based norms. These students experienced lockdowns in Grade 1, returned to regular face-to-face instruction in Grade 2, and were tested at the beginning of Grade 3 to determine if disruptions had negatively impacted the normal trajectory in the acquisition of component reading skills and reading development. Additionally, we examined whether vocabulary, PA, program of instruction or SES influenced post pandemic reading attainment one year after the return to regular instruction. In line with previous research, vocabulary (Baumann et al., 2003; Cain & Oakhill, 2014; Nagy, 2007) and phonological awareness (Bradley & Bryant, 1978, 1983; Hogan et al., 2005; National Early Literacy Panel, Lonigan et al., 2008) were statistically significant predictors of reading ability across all component reading skill areas. Comparative analysis from pre-pandemic WISC-V vocabulary norms, as a measure of crystallized intelligence, suggests that study participants are typical children with average learning potential. Yet, one year after the return to regular face-to-face instruction, 74% of students attained reading scores in the at "risk-range" (bottom quartile) on one or more component reading measures.

When analyzing English reading results across all five schools, including those in French Immersion, we found that even though there were differences in how well students were doing within each school, the overall performance was similar across schools and types of programs. For English word reading, we found double the amount (50%) of students falling in the bottom quartile compared to the

predicted 25%. The findings are even worse for decoding, word reading fluency and decoding fluency (see Table 2).

Despite significant heterogeneity observed within schools, homogeneity was observed across schools and program types. This is an interesting finding because for French Immersion students in British Columbia, English literacy instruction is only introduced in the curriculum in Grade 3 (BC Ministry of Education). This means that, for our French Immersion students, no formal English reading instruction had taken place prior to data collection. English parents with limited French background, who were thrown into the role of teaching during lockdowns had few language resources available to facilitate their children's French literacy instruction. Comparatively, parents across the district, regardless of the program in which their children were enrolled, had the similar ability to support their children's English reading skills during lockdown subsequently leading to similar reading skills development. Nevertheless, students in the regular English stream had an additional year of English instruction after lockdowns while French Immersion students were learning in French and had not yet been introduced to formal English instruction. Regardless of how disrupted their instruction was in Grade 1 due to lockdowns, students in the English program should have, at minimum, been performing a full year ahead of their French immersion peers.

A possible explanation for the lack of expected difference between students in French Immersion and English programs is the impact of SES on reading achievement. Our results indicate that high SES was associated with stronger word reading and was seen as a protective factor for our most affluent students. The school with the highest SES happens to be one of the French Immersion schools. During lockdowns, students from lower-income families had access to fewer resources and less technology (National Centre for Education Statistics 2020; Bacher-Hicks et al., 2021; Kuhfeld et al., 2020). Within the partner school district, internet connectivity and computing devices were provided to low SES students to enable access to online learning. Additionally, a large proportion of low-income

families had parents who were considered essential workers (i.e., cashiers, care aides, delivery drivers, etc.) who were crucial to maintaining services during lockdowns (Kochhar & Benenson, 2020). This placed additional strain on these families during a time of crisis (Sugg et.al., 2021) impacting parents' availability to engage in online or remote learning activities with their children, and consequently increasing the SES digital divide and exacerbating CLL for low-income students (Kuhfeld et al., 2020).

Accordingly, French Immersion children from higher SES demographics performed significantly better than their less affluent peers. This helps explain why French Immersion students were performing on par with their English peers on the measure of English word reading despite having had no formal English reading instruction. Students enrolled in early immersion programs, where all academic instruction is delivered in French during the initial years, often experience a delay in the development of foundational literacy skills (reading, writing, and spelling) in their first language (Genesee, 2004). Research, however, indicates that they typically reach parity with their peers who receive instruction exclusively in their first language after approximately one (Genesee, 2004) to two years (Au-Yeung et al., 2015) of first language instruction. This suggests that for our cohort we would expect them to continue to lag behind their English educated peers, reaching parity, at the earliest, between the beginning of Grade 4 and the onset of Grade 5. (Au-Yeung et al., 2015; Genesee, 2004). This was not the case, prompting several questions for future research such as: a) is there a cumulative advantage of higher SES and learning a second language that counteracted the expected reading discrepancy between French and English schools, and potentially acted as a protective factor for some immersion students or b) was reading development interrupted to such a great extent that, regardless of formal program of instruction, the observed results represent a regression of skills and a floor effect?

### **Limitations**

One limitation is that this study focused on 214 students within the British Columbia context who were in Grade 1 when pandemic school closures began, and results may not be generalizable across

different-aged cohorts or geographical locations. Mean score differences could theoretically have previously existed with this cohort; however, it is statistically improbable that a normal distribution on vocabulary measures, as a proxy for ability or potential learning, would result in such discrepancies in reading outcome variables. While homogeneity of findings across schools may be due, in part, to the limited number of schools in the study, an alternative rationale is that reading skills for this cohort of children were significantly delayed regardless of instructional program. Little variability is evident between schools because of a floor effect on all the reading measures making it difficult to compare the means between two groups such as English and French immersion. These findings are significant because they highlight the impact a prolonged gap in learning can have on developing literacy skills one year after the return to in-person instruction when no structured interventions are put in place.

### **Conclusion**

The impact of the pandemic on educational outcomes may take years to be fully realized. This research adds to the growing body of evidence that suggest educational disruptions during the pandemic resulted in significant and enduring reading delays for students. The emerging evidence indicates that although best efforts were made to continue student learning through online platforms and pedagogies, the results were ineffectual and similar to those achieved in summer months when there is no direct instruction (Hammerstein et al., 2021). Our findings are in alignment with previous research demonstrating that primary students (Tomasik et al., 2021), and children from disadvantaged families (Engzell et al., 2021; Maldonado & De Witte, 2021), were more negatively impacted by COVID-19-related school closures. Of significant concern, are the students whose learning was interrupted in Grade 1, when foundational reading skills typically begin to solidify, as described by Ehri's (2020, 2005) phase theory of reading. Some of these primary students may have experienced regressions in their reading skills, effectively reversing into previous reading phases as skills weakened or were lost. With

the loss of direct instruction, students who were in the partial alphabetic phase, may have reverted to the pre-alphabetic phase (Ehri, 2020,2005)/logo graphic stage (Frith,1985).

Importantly, this research demonstrates that when students did return to in-person instruction their reading skills continued to significantly lag behind expected performance norms for the age group. Moreover, the data revealed that the English students performed as poorly as the French Immersion students, who did not receive formal English reading instruction. This finding suggests that primary students suffering reading loss due to significant gaps in instruction and structured learning time, do not simply carry-on where they left off in their abilities, but suffer significant delays and/or regression of skills. Furthermore, a large percentage did not recover from the learning losses one year after the return-to-normal instruction during second grade. These students were in Grade 3 at wave one of data collection for this study. The proportion of Grade 3 students falling in the at-risk range is significant, as research shows that students who are still struggling readers by Grade 4 often continue to experience reading challenges throughout their life span (National Early Literacy Panel, Lonigan et al., 2008; Ritchev et al., 2013). Moreover, this is particularly true for students who do not receive targeted instruction or early intervention services (Lovett et al., 2017; Wanzek & Vaughn, 2007). If the CLL is not addressed, the cost to individuals, their communities, and society may be considerable, particularly in view of the high rates of school dropout (Reschly, 2009), incarceration (Grigorenko, 2006; Rucklidge et al., 2009), substance abuse (Lyon, 2001), unemployment, and mental health concerns (Pape et al., 2011) associated with illiteracy. As such, it is crucial to determine what specific foundational component reading skills are delayed during this time-sensitive developmental window and to track the students' literacy development over time.

COVID-19 is an inflection point in our history and is an opportunity to enhance our understanding of reading theories, the normal trajectory of reading development, and what transpires when that trajectory is disrupted. This knowledge can inform educational leaders in supporting primary

students' recovery from future learning losses due to educational disruptions (e.g. climate disasters, wars, etc.). If reading instruction does not adequately account for the regression of skills, students may not have the needed foundation to recover from sustained learning losses and may continue to languish. This understanding may also inform future remedial practices to support students in recovering from reading delays and/or regressions in reading skills resulting from disruptions. In conjunction with identifying specific component reading delays, it is equally important to recognize added risk and protective factors in order to prioritize intervention services for the student demographics most susceptible to continued reading delays. Further research is needed to track students impacted by large-scale disruptions to determine how quickly, and to what extent, students' reading levels will recover and whether there are risk and protective factors that impact that rate of recovery from sustained learning losses. A failure to adequately address these learning gaps may result in a large cohort of children being at risk of lifelong literacy challenges. With this information and baseline established, we will be able to track this cohort longitudinally and determine if decisions made by our partner school district are having positive results.

**Chapter IV: Study 2**

**Longitudinal Impact of Educational Disruptions on Elementary Reading Development:**

**Tracking COVID-19 Learning Loss**

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### **Abstract**

Approximately one in six Canadians are functionally illiterate (Statistics Canada et al., 2013), a widespread issue with significant societal costs (OECD, 2019; World Literacy Foundation, 2018). The COVID-19 pandemic disrupted the global education system, creating uncertainty about its long-term impacts on literacy, while highlighting the need to examine COVID Learning Loss (CLL) and the developmental trajectory of foundational reading skills in early elementary students. This project followed 247 students who were in Grade 1 when COVID restrictions began and had just entered Grade 3 at the start of phase one data collection. While the data shows a steady and ongoing recovery from CLL, by Grade 4 the majority of students were still falling far short of pre-pandemic achievement levels. Additionally, typical risk/protective factors did not significantly mitigate or moderate the rate of recovery suggesting that disruptions to learning at critical developmental phases has a broad sweeping blanket effect on all learners. This emphasizes the critical role of a comprehensive academic recovery plan, as resilience alone does not enable students to spontaneously regain lost learning.

*Keywords:* foundational reading skills, COVID -19 pandemic, COVID learning loss, educational disruptions, component reading skills, direct and indirect effects of reading model (DIER), phase theory of reading development, risk factors, protective factors

## Introduction

### **Investigating the Long-Term Impact of Educational Disruptions on Early Reading Development:**

#### **Tracking COVID-19 Learning Loss and Recovery**

Approximately one in six Canadians are functionally illiterate (Statistics Canada, et al., 2013), a pervasive issue that not only affects individuals but also exacts a profound toll on society, resulting in extensive costs across various sectors including health, economy, employment welfare, and the justice system (Organization for Economic Co-operation and Development [OECD]. 2019; World Literacy Foundation, 2018). Research from the Programme for the International Assessment of Adult Competencies (PIACC) found that approximately 50% of Canadian adults did not pass a high school-level literacy assessment (OECD, 2019). Furthermore, children who have not attained proficient reading skills by the fourth grade often encounter challenges across various academic domains by the time they reach eighth grade, with these difficulties frequently persisting into adulthood (National Early Literacy Panel, Lonigan et al., 2008; Ritchey et al., 2013). This underscores the importance of understanding how learning disruptions in students' formative years impacts reading development. The COVID-19 pandemic led to substantial disruptions in the global educational landscape, warranting a closer examination of the long-term impacts on the acquisition of foundational reading skills among early elementary students.

As educators and scholars grapple with understanding the enduring impact of these disruptions, theoretical frameworks on resiliency (Bronfenbrenner & Morris, 2006; Masten, 2014; 2020) information processing (Atkinson & Shiffrin, 1968), and the direct and indirect effects model of reading (DIER; Kim, 2020) offer valuable conceptual lenses through which to examine the complex dynamics and multifaceted nature of learning to read. Guided by these theoretical underpinnings, this study explores the impacts of educational disruptions on early elementary students developing reading skills. Building on our previous study, which found that 74% of students were at risk in one or more component reading

skills, (Boulet et al., 2023) our current investigation focuses on tracking the proportion of students who continue to experience reading difficulties two and three years after the COVID lockdowns.

Furthermore, we seek to explore whether students naturally rebound or recover to predicted achievement levels once consistent face-to-face instruction is reintroduced. A key objective of our research is to probe factors that shape the rate of recovery in reading proficiency. Specifically, we seek to identify risk and protective factors that may have influenced the trajectory of students' reading development once regular instruction resumed.

### **COVID Learning Loss**

Large scale adversity (e.g., natural disasters, pandemics, and wars,) particularly during important formative phases creates risk factors that may have profound and long-lasting effects on early childhood developmental trajectories (Masten, 2018). Most scholars seem to agree that student learning faced significant setbacks due to COVID-19 disruptions (e.g., Donnelly & Patrinos, 2021; Maldonado & De Witte 2021; Tomasik, et al., 2020). A recent meta-analysis of multiple studies across different regions offers a comprehensive understanding of the long-term impacts of COVID-related learning loss on academic achievement (Di Pietro, 2023). The synthesis of findings highlights that while learning loss was observed universally, the extent varied based on factors such as socio-economic status (SES), educational resources, and parental engagement (Di Pietro, 2023) which aligns with resiliency and risk research (i.e., Boon, 2008; Masten, 2020). Resiliency is generally defined as the capacity to successfully adapt to adversity whereas, student risk refers to exposure to conditions that increase the likelihood of poor, developmental trajectories (Boon, 2008; Masten, 2020) and more specifically reading outcomes (Fletcher et al., 2021; Snowling, 2000). Resilience is understood as the dynamic interaction between multiple interconnected systems—such as individuals, families, schools, and communities—that evolve together and support adaptation to adversity (Masten, 2014, 2020). This interaction includes supportive relationships with caregivers and teachers, as well as broader systems like community programs and

school-based interventions. Notably, the BC Ministry of Education and Childcare prioritized social emotional learning and mental health to build resiliency as the provincial system emerged from the pandemic (Wong, 2022). Remarkably, there was a lack of province wide systematic direction when it came to academic recovery from CLL (British Columbia Ministry of Education and Childcare, 2021; Wong, 2022). A growing body of research reveals the complex nature of the issue and reinforces the urgency of addressing learning disparities in the post-pandemic educational landscape (e.g., Engzell, Frey, & Verhagen, 2023). Moreover, the evidence suggests that the detrimental effects of pandemic related disruptions on student academic achievement will persist over time (e.g., Di Pietro, 2023; Hanushek & Woessmann, 2020; Psacharopoulos et al., 2021).

Collectively, the literature underscores the complex relationship between the COVID-19 pandemic, learning loss, and academic achievement in reading. While the literature provides valuable insights into COVID-related learning loss (CLL) and its impact on reading achievement, certain limitations remain. Of note, many of the studies rely on short-term data due to the recency of the pandemic, which may not fully capture the long-term consequences on reading development (e.g., Dorn et al., 2020; Gore et al., 2021; Kuhfeld et al., 2020; Maldonado & De Witte, 2021; World Bank, 2022). Moreover, evidence suggests that educational disruptions had a profound impact on younger children (e.g., Kogan & Lavertu, 2021, , Tomasik et al., 2021) whose component reading skills were still in their infancy when lockdowns took place (Relyea et al., 2023). In alignment with this assertion, US results from the National Assessment of Educational Progress (NAEP) in 2022 showed a statistically significant decline in 9-year-olds average reading scores compared to 2020 - marking the largest drop since 1990 (U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, n.d.). Similar to our study's participants, most of these students were in Grade 1 during the 2019/2020 school year, when extended school closures disrupted learning. This trend is important to the current study as it highlights the degree to which academic performance has been impacted for early learners. There is a

critical need to understand the long-term educational impact of COVID-19, with particular focus on how early reading development has been affected and the rate at which students recover from CLL. It is essential to determine whether, and to what extent, students whose learning was disrupted have managed to regain their academic footing in reading and whether risk and protective factors moderated the rate of change.

### **Theoretical Underpinnings**

Understanding risk and protective factors related to reading development is crucial in the context of tracking the recovery from CLL. Masten's work on resilience emphasizes that the timing of adversity, such as disruptions to education during critical developmental periods, plays a crucial role in determining long-term impacts (Masten, 2018). Moreover, her resilience framework highlights how multiple interconnected systems all play critical roles in helping children adapt to adversity (Masten, 2018). Whereas theoretical frameworks such as Ehri's phase theory of reading development (2005, 2020) and the Direct and Indirect Effects of Reading (DIER) model (Kim, 2017, 2020), help provide an explanation for how reading develops over time and its multiple components. The progression of reading skills acquisition is typically described in developmental stages, as outlined in Ehri's (2005, 2020) phase theory of reading development. While, the DIER model emphasizes the importance of both indirect factors, which involve broader contextual or environmental influences as well as direct factors specific to reading-related skills.

***Indirect Factors:*** Although not directly involved in reading, indirect factors play a crucial role in supporting and facilitating the development of reading skills. Socioeconomic status (SES) is an indirect factor typically associated with academic risk and impacts on reading development (Boon, 2008, Buckingham, et al., 2013, 2014; Dolean, et al., 2019). However, access to resources, social capital, and family investments can also function as protective factors for children in higher SES environments (Bronfenbrenner, 1979). Similarly, summer learning loss (SLL) can be a significant risk factor in reading

development, particularly for students who lack access to educational resources during the summer months (Alexander et al., 2007). The SLL research emphasizes how interruptions of formal education during summer breaks can disproportionately affect students' achievement (Atteberry & McEachin, 2021; Cooper et al., 1996). COVID related disruptions represent an even larger academic interruption than a traditional summer break, making an investigation into SLL pertinent to the current study. Additionally, students from cultural and linguistically diverse backgrounds are often at higher risk of reading delays (Vaughn et al., 2005). Pandemic disruptions to education may have exacerbated challenges related to these broader indirect influences, potentially impacting students' reading development. Consequently, these were central to our investigation of CLL recovery.

**Direct Factors:** Direct factors encompass specific reading-related skills such as phonological awareness (PA), decoding, fluency, and vocabulary (Kim, 2017, 2020). Weaknesses in PA, are considered one of the most studied risk factors related to reading development while strengths in PA serve as a protective factor (Ehri, 2005, Snowling, 2000). Similarly, there is considerable evidence indicating that poor vocabulary is a risk factor in reading development, emphasizing its role in comprehension, language processing, and overall literacy success (Chall, 1983; Gough & Tunmer, 1986; Perfetti, 2007; Stanovich, 1986). Vocabulary knowledge is also fundamental to reading success and can serve as a protective factor by enhancing decoding, comprehension, and the ability to engage with increasingly challenging texts (Perfetti, 2007; Slomowitz et. Al., 2021). These factors, when compounded by the disruptions caused by COVID-19, increase the risk of reading delays, making them important to our investigation of CLL recovery. The current investigation is a longitudinal study that monitored a cohort of students and their reading proficiencies across three distinct waves of data collection. We tracked growth over a school year when students had direct instruction (fall and spring) and followed up in the fall of the subsequent school year to track year over year growth and account for any summer learning loss (SLL). The objective of this research was to investigate potential risk and protective factors that

could have influenced literacy acquisition among elementary students following disruptions caused by the pandemic. In our investigation, we focused on both direct and indirect factors influencing the development and acquisition of component reading skills. Specifically, we examined direct factors such as a) vocabulary, b) phonological awareness, c) letter and word recognition, d) decoding, e) word reading fluency, and f), decoding fluency, and indirect factors including a) SES, b) cultural and linguistic differences (e.g., indigenous heritage, English language learners), c) French immersion instruction), and d) attendance. Importantly, we were able to observe these dynamics in the absence of targeted reading interventions or systemic changes, thereby shedding light on the inherent resilience or vulnerability of early elementary students to educational disruptions. Consistent with the literature, we operationalized student's performance on component reading skills as falling in the at-risk range when their scores are within the bottom quartile (i.e.,  $\leq 25^{\text{th}}$  percentile) (Lindsey et al., 2003; Wise et al., 2007). Our research is unique in that, to our knowledge, there has never been a large cohort of children at-risk of reading failure for whom outcomes transpired naturally (i.e., without a system wide academic COVID recovery plan) to determine what protective factors allowed them to recover from CLL and which risk factors contributed to continued reading delays.

### **Methods**

This research was supported by the Social Sciences and Humanities Research Council of Canada SSHRC, Partnership Engage Grant in collaboration with a school district in British Columbia.

### **Participants**

The project focused on those students who were enrolled in Grade 1 in March of 2020 when COVID restrictions began. These students entered Grade 3 in September 2021 at the start of phase one data collection. A total of 247 children across 5 elementary schools (three English and two French immersion), were included in this longitudinal study. All French immersion students were native English speakers who, prior to the first wave of data collection, had received formal literacy instruction

exclusively in French. English literacy instruction was not introduced until Grade 3. Extensive research suggests that assessing children's language and cognitive abilities in their first language allows for early identification of those susceptible to word-based reading challenges in their second language (August & Shanahan, 2006; Da Fontoura & Siegel, 1995; Erdos et al., 2011; Geva & Clifton, 1994; Jared et al., 2011; MacCoubry et al., 2004). This evaluation can be conducted before their proficiency in the second language is fully developed and reliably predicts subsequent reading outcomes (Da Fontoura & Siegel, 1995; Geva & Clifton, 1994; Jared et al., 2011; MacCoubry et al., 2004).

Our partner, school district in British Columbia, Canada was the curator of the data and released anonymized secondary data to the researcher. As such, no formal recruitment was required. There were no exclusion criteria - all students who were enrolled in Grade 3 at wave one (fall 2021) and wave two, (spring 2022) and in Grade 4 at wave three (fall 2022), at participating schools were included in the study. Table 2 outlines the demographic breakdown of participants in the study. The breakdown of students is similar to the norm referenced group. For example, 3 students with special education designations were diagnosed with an intellectual disability representing 1.4% of the sample. Similarly, 1.4% of the normative sample for the Kaufman Test of Educational Achievement, third edition (KTEA-3) were identified as having an intellectual disability (Kaufman et al., 2014 p. 33).

**Table 7**

*Breakdown of Participants*

Demographic	Total	Male	Female
Number of Participants	247	121	126
English	148	80	68
French Immersion	99	41	58
Special Education Designation	16	10	6
Indigenous Heritage Total	34	15	19
English Language Learners (ELL) a	8	5	3
Mean Age in Months Wave 1b	99.35	99.20	99.51
Mean Age in Months Wave 2c	107.02	106.70	107.30
Mean Age in Months Wave 3d	111.19	110.95	111.40

*Note.* <sup>a</sup>ELL students who are not also Indigenous. <sup>b</sup>Computed on a sample of 214. <sup>c</sup>Computed on a sample of 210. <sup>d</sup>Computed on a sample of 216.

Consistent with existing research, our emphasis was on foundational reading skills commonly featured in early screening assessments including word reading, phonological awareness, decoding, and fluency (Jenkinson et al., 2007), as these are essential prerequisites for the development of proficient reading comprehension (McKenna & Stahl, 2009; Gough & Tunmer, 1986; Hoover & Gough, 1990; Kim, 2017, 2020; Scarborough, 2001). These measures include selected subtests from the Canadian edition of Wechsler Intelligence Scale for Children Fifth Edition (WISC-V; Wechsler, 2015), Kaufman Test of Educational Achievement, third edition (KTEA-3; Kaufman & Kaufman, 2014), and the Comprehensive Test of Phonological Processing - Second Edition (CTOPP – 2; Wagner et al., 2013). Each of these norm-referenced standardized tests yield measures with a standard score mean of 100 and a standard deviation of 15. Standard scores from these measures are derived by comparing student's raw scores to those obtained by a large norm group of similar-aged children. According to pre-pandemic population norms for these well-established norm-referenced standardized measures, 25% of students would be expected to achieve results in the first quartile, falling at or below a Standard Score of 90 (Guilmette et al., 2020) with the remaining 75% meeting or exceeding grade-level expectations.

### ***Vocabulary***

The WISC-V Vocabulary subtest was administered once to each student at their entry point into the study and was used to gauge student's word knowledge and verbal concept formation. This subtest also measures crystallized intelligence, fund of knowledge, and degree of vocabulary development. Children were presented a word orally and were asked to provide a verbal definition of the target word. The split-half reliability coefficient for the vocabulary subtest is reported at .89. The test manual reports adequate content, construct, and criterion-relation validity (Wechsler, 2015).

### ***Phonological Awareness***

The CTOPP-2 Elision subtest was used to assess students' phonological awareness skills. This subtest requires students to say the word that remains after deleting syllables (early items) or

phonemes (later items) (e.g., “Say *basketball*. Now say *basketball* without saying *basket*.” Or “Say *sprain*. Now say *sprain* without saying ‘r’.”). The coefficient alpha as a measure of internal consistency is reported as .91. The test manual reports adequate content, construct, and criterion-relation validity (Wagner et al., 2013).

### ***Word-level Reading***

English word level reading accuracy was assessed using the KTEA-3 Letter Word Recognition subtest, which measure the ability to identify letters and read both regular and irregular words. Regular words are those that are read correctly by applying phonological decoding principles, and irregular words are those words that can be read correctly only if the student is familiar with the word. The students were given a list of words of increasing difficulty to read aloud. The test manual reports adequate content, construct, and criterion-related validity. The split half reliability coefficient for letter word recognition has a mean of .97 for Grades K-12 (Kaufman & Kaufman, 2014).

### ***Decoding***

The KTEA-3 Nonsense Word Decoding subtest was used to measure the ability to transform printed letters and letter patterns into sounds and to integrate those sounds into a pronunciation that conforms to rules of standard English. Students were given a list of increasingly difficult non-words to read aloud according to English phonetic rules. Students were required to apply knowledge of phonemes (units of sound in language) to graphemes (letters) to correctly pronounce made-up words, drawing on phonological awareness. The test manual reports adequate content, construct, and criterion-related validity. The split-half reliability coefficient for nonsense word decoding has a mean of .96 for Grades K-12 (Kaufman & Kaufman, 2014).

### ***Word Reading Fluency***

The KTEA-3 Word Recognition Fluency task was used to measure reading fluency using graded lists of real words. This timed subtest requires students to accurately read a list of words allowed as

quickly as possible during two 15-second trials. The test manual reports adequate content, construct, and criterion-related validity. The split half reliability coefficient for Word recognition fluency has a mean of .86 for Grades K-12 (Kaufman & Kaufman, 2014).

### ***Decoding Fluency***

The KTEA 3 Decoding Fluency task measures decoding fluency using graded lists of made-up words. This timed subtest requires participant to read a list of nonsense words aloud as quickly as possible during two 15-second trials. The test manual reports adequate content, construct, and criterion-related validity. The split-half reliability coefficient for decoding fluency has a mean of .82 for Grades K-12 (Kaufman & Kaufman, 2014).

### **Design**

This longitudinal research utilized an anonymized secondary data source from our partner school district. We employed standardized instruments that were normed on pre-pandemic populations to assess students' progress in reading, comparing their performance to expected age-based benchmarks. These well-established, valid and reliable tools are commonly utilized by school psychologists to evaluate students for diagnostic purposes, by comparing their results to those of a normative group. Except for the vocabulary measure, which was only collected at the participants' entry in the study, all other measures, design, general data collection and administration procedures remained the same as study one (Boulet et al., 2023).

### **Procedures**

The school district assessed students individually in a quiet setting (e.g., learning assistance room, library) at the elementary school in which they were enrolled. Raw data for the reading and vocabulary measures were collected through iPad administration and entered into the partner school district's online assessment platform. For the PA measures the customary paper and pencil standardized administration procedures established by the test developers were used. Starting points

and discontinuation rules were followed for each measure in accordance with their respective test manuals. Raw scores and standard scores were recorded for each measure. The school district released the secondary anonymized raw scores and derived scores (i.e., standard scores, percentiles, and Growth Scale Values [GSV]) for analysis. In addition, they provided existing anonymized demographic information (e.g., gender, ethnicity, special education designation, program enrolment etc.) linked to neighborhood-aggregated census data indicating SES.

The Vocabulary subtest of the WISC-V was administered only once during the initial wave of data collection because it was used as a proxy for ability and crystallized intelligence, providing a stable measure of verbal reasoning skills. Unlike other reading measures, which were collected during each wave to track changes in reading development over time, the Vocabulary subtest does not have an alternate form for successive administrations. Repeated use of the same test items would have introduced a practice effect, undermining the validity of subsequent assessments. Furthermore, the test-retest reliability coefficient for the Vocabulary subtest on the WISC-V is high ( $r = .92$ ), indicating strong stability of scores over time (Wechsler, 2015). Thus, given its robust psychometric properties and the need to avoid practice effects, it was determined that administering the Vocabulary subtest at each wave was unnecessary, as scores were unlikely to change significantly over the three waves of data collection.

For each data collection phase, achievement measure raw scores were converted to standard scores in order to assess the proportion of students whose component reading skills continued to fall within the at-risk range compared to pre-pandemic norms, two and three years after lockdowns. While standard scores are a useful metric to compare students to expected performance (i.e., pre-pandemic norms), they are less valuable for longitudinal assessment to compare student's growth in performance or change in skill level over time (Farmer, et.al., 2020; Moller, 2015). Because standard scores reflect the relationship between actual performance and age expected performance, they can decrease even if raw

performance has improved (Eisengart et al., 2022). For instance, when a student's growth rate is slower than average (compared to the norm group) the resulting standard score may decrease despite actual growth because the comparison is relative to the norm not their previous performance. Consequently, raw scores are often used to describe student absolute growth over time.

However, raw scores can also be problematic as they do not represent an equal interval scale, and, as Eisengart et al. (2022) note, test developers are unable to evenly distribute item difficulty across their entire range. Moreover, when tests are administered in sets and student's must reverse to an easier level, raw scores are often listed as weighted raw scores and are not easily interpretable on their own. A raw score of 15 on the easier list of words is not the same as a raw score of 15 on the more advanced list of words. If the student began at wave one of data collection with the easier list of words and at wave two or three graduated to the higher list of words, a later score of 12 on the more complex list of words would erroneously suggest a decrease in ability.

As such we chose to use Growth Scale Values (GSVs) to measure students rate of growth or change overtime on component reading skills. GSV's are a type of derived score that reflect an examinee's level of performance on a test (Daniel & Vannier, 2022). Like raw scores, GSVs indicate the child's absolute level of performance while also providing an estimate of underlying ability based on item difficulty reflecting how well the child performed on the test items (Eisengart, et.al., 2022). The key distinction between raw scores and GSVs is that a raw score represents a total of correct responses on a specific set of test items, while a GSV estimates the underlying ability level that most likely produced those scores (Eisengart et al., 2022). Person-centered ability scores, such as GSVs, have also been endorsed as a better metric for reflecting changes in individual ability rather than difference from typical developmental trajectories (Farmer et al., 2020). The equal intervals represented by GSVs enable a consistent measurement of change across different developmental and chronological ages (Eisengart et al., 2022). Unlike raw and standard scores, GSVs provide greater assurance that the observed

differences accurately reflect changes in ability across the age spectrum (Daniel & Vannier, 2022; Eisengart et al., 2022).

### ***Statistical Procedures***

Multilevel modeling (MLM) was employed to address research questions pertaining to the rate of recovery from CLL in component reading skills and to explore whether individual and contextual factors, such as a) vocabulary, b) phonological awareness, c) SES d) program of instruction (i.e., English or French Immersion), e) cultural and linguistic factors (i.e., ELL and indigenous ancestry) and f) attendance etc., moderated the rate of skill acquisition, acting as either risk or protective factors for specific groups of students. This method was chosen to study the long-term impacts of CLL on reading proficiency as it offers several advantages over repeated measures models, particularly when analyzing data across nested structures, such as students within schools. Unlike repeated measures models, MLM can account for hierarchical data, where observations at different levels (e.g., student, classroom, school) are interdependent, thus preventing issues of autocorrelation within groups and the violation of data independence inherent in repeated measurement designs (Stawski, 2013). This model allows researchers to partition variance across levels, enhancing the precision of estimates by recognizing both fixed and random effects (Stapleton et al., 2016). Moreover, MLM uses restricted maximum likelihood (REML) estimation, which provides unbiased estimates of variance components and improves model fit, particularly with smaller sample sizes such as ours. By doing so, it maximizes statistical power and more accurately reflects population-level effects. Furthermore, MLM allows for cross-level interactions and greater flexibility in handling missing data, such as student attrition and new enrollments across the duration of our study, thus increasing the robustness of inferences able to be drawn. These features make MLM preferable for capturing the contextual influences and individual-level variations that repeated measures models may overlook (Raudenbush & Bryk, 2002; Stapleton et al., 2016). Spline models were also utilized to address variations in slope across time and more specifically to address SLL.

Lastly, we utilized time-varying coupling models to further explore the within-student effects of PA acquisition in tandem with component reading skills to capture the mechanistic relationships between these variables across different waves.

Two-level multilevel models were used to account for the specific structure of the data where repeated assessments (level-1) were nested within students (level-2). While it is also true that schools represent a potential third-level influence on data dependence (i.e., student's being more similar to peers within a school than across schools), intraclass correlation coefficients computed for these three-level models revealed that less than 1% of variance in the outcomes of interest were related to school-level differences. Accordingly, given our specific interest in level-1 and level-2 predictors, there was no advantage in a more computationally intensive three-level model.

Initially, unconditional models (i.e., models without predictors) were fit to investigate the within-and between-person variance associated with each outcome of interest. Subsequent conditioned models were then fit with both between-person and within-person predictors to explain some of the remaining variance in each component reading skill. Variables that were assessed at only one time point (e.g., vocabulary), or variables that did not change across the course of the study (e.g., SES, gender) are natural between-person (level-2) predictors, whereas time-varying predictors - variables that were assessed at each wave (e.g., phonological awareness, etc.) - are within-person (level-1) predictors.

Given the fact that between wave 2 and wave 3 of data collection the students were on summer break, time had to be operationalized deliberately so as not to assume constant linear change across all three waves. Treating time as a linear learning constant would neglect to account for any potential changes in skill acquisition that took place across the summer, thereby confounding the estimated rate of skill acquisition. As such, two operationalizations of time were included in the model, one being the rate of change across grade 3 (i.e., wave 1 to wave 2, denoted 'Grade 3' in the models) and the other being the rate of change across the summer (i.e., from wave 2 to wave 3, denoted 'Summer'). Both the

Grade 3 and summer acquisition slopes were centered at the latest assessment time for wave 2 (i.e., 8.12 months in the study), such that the intercept of all subsequent models is interpretable as a student's performance immediately prior to the summer break. In this way, each model is estimating the rate of learning acquisition across Grade 3 and the summer, empirically testing the question of any SLL.

Equation 1 depicts the equations for a fully conditioned model using word reading as the outcome. This equation dictates that word reading scores for a given student ( $i$ ) at assessment ( $j$ ) are modeled as a function of that student's time in study prior to the summer break (Grade 3) and time in study across the summer break (Summer), plus an error term ( $e$ ). Person-level covariates (level-2) included a student's baseline phonological awareness ability (centered at the average phonological awareness score for students at-risk in the respective component reading skill at wave 1;  $PA\_C$ ), a risk variable denoting whether a student was at-risk in the respective component reading skill at baseline (Risk), and the interaction between these two variables. All these level-2 variables were fit to moderate the intercept (i.e., average word reading score at the end of grade 3, for not at-risk students with average phonological awareness performance), and both Grade 3 and summer slopes. Thus, each model is testing whether a) at-risk students score differently than not at-risk kids at the end of Grade 3 when holding phonological awareness constant, b) at-risk students change differently than not at-risk students across Grade 3 and the Summer, and c) phonological awareness performance at baseline modulates the rate of change across Grade 3 and the Summer for at-risk or not at-risk students. Random effects were also modeled, with the level-1 residuals ( $e_{ij}$ ) reflecting within-person assessment-to-assessment variability, and the level-2 residuals ( $U_{0j}$ ,  $U_{1j}$ ) reflecting between-student differences in word reading performance at the end of Grade 3 and between-student differences in the rate of change across Grade 3, respectively. A preliminary investigation estimating level-2 random effects of the summer slope

indicated that there were no significant between-person differences in the rates of change across the summer and thus were excluded from the final models.

Equation 1:

**Level 1 (Within-Student Change):**

$$\text{Word Reading}_{ij} = B_{0j} + B_{1j}(\text{Grade 3 Slope}_{ij}) + B_{2j}(\text{Summer Slope}_{ij}) + \varepsilon_{ij}$$

**Level 2 (Between Student Differences):**

$$B_{0j} = \gamma_{00} + \gamma_{01}(\text{PA\_C}) + \gamma_{02}(\text{Risk}_j) + \gamma_{03}(\text{PA\_C} * \text{Risk}_j) + u_{0j}$$

$$B_{1j} = \gamma_{10} + \gamma_{11}(\text{PA\_C}) + \gamma_{12}(\text{Risk}_j) + \gamma_{13}(\text{PA\_C} * \text{Risk}_j) + u_{1j}$$

$$B_{2j} = \gamma_{20} + \gamma_{21}(\text{PA\_C}) + \gamma_{22}(\text{Risk}_j) + \gamma_{23}(\text{PA\_C} * \text{Risk}_j)$$

Finally, to probe the within-person associations between component reading skill performance and phonological awareness (i.e., a level-1 time-varying predictor) predictor variables, regardless of time-based change, we also leveraged time-varying covariation models (i.e., coupling models). Coupling models are a specific type of MLM that examine whether within-person variability in phonological awareness moves in tandem with changes in component reading skill performance. In this way, coupling models provide a compelling within-person investigation of the potential mechanistic relationship between performance on a component reading skill and level of phonological awareness; specifically, asking whether they systematically covary across time. These models investigate the protective and/or risk influence that PA has within an individual, which may differ in both magnitude and direction from how PA manifests at the group level (Gnaldi et al., 2018). To facilitate this investigation, phonological awareness was person-mean centered (PA\_pmc), thereby allowing the examination of change relative to a student's own average performance on PA (see Equation 2). Time in study (TISmon) refers to time, measured in terms of number of months elapsed since baseline assessment or the participants initial testing. The rest of the variables in Equation 2 are operationalized the same as they were in Equation 1.

Equation 2:

**Level 1 (Within-Student Change):**

$$\text{Word Reading}_{ij} = B_{0j} + B_{1j}(\text{TISmon}_{ij}) + B_{2j}(\text{PA\_pmc}) + \varepsilon_{ij}$$

**Level 2 (Between Student Differences):**

$$B_{0j} = \gamma_{00} + \gamma_{01}(\text{PA\_C}) + \gamma_{02}(\text{Risk}_j) + u_{0j}$$

$$B_{1j} = \gamma_{10} + \gamma_{11}(\text{Risk}_j)$$

$$B_{2j} = \gamma_{20} + \gamma_{21}(\text{Risk}_j) + u_{2j}$$

All models were estimated using full information maximum likelihood, which is flexible to missing data (i.e., to students missing one or two waves of assessment). Moreover, this estimation technique adjusts the final model parameters as a function of differential weighting towards students who were present for all three waves (Kreft & de Leeuw, 1998). Additional level-2 covariates, including age, sex, language of program instruction, attendance and SES were initially included but were removed from subsequent models as they failed to surpass statistical significance levels and did not significantly affect model fit or parameter estimates.

## Results

This study aimed to shed light on three key areas related to post-COVID reading development. First, we tracked the proportions of students who remain at risk for reading difficulties, analyzing whether these numbers have shifted two and three years after the COVID-19 lockdowns. Second, we examined the rate of recovery from COVID-related learning losses, assessing how students' reading skills have evolved over time and whether they are returning to pre-pandemic performance levels. Finally, we explored whether protective factors, such as vocabulary, phonological awareness, and SES, a) moderated the rate of skill acquisition, potentially influencing students' ability to recover more quickly from pandemic-related disruptions and b) predicted component reading skill levels at each wave of data collection.

### Proportion of Students At-Risk

To examine the proportion of students who persist in experiencing reading difficulties two- and three-years post COVID-19 lockdowns we compared standard score results to expected pre-pandemic population norms (See Table 7). WISC-V Vocabulary was only assessed once at the time of entry into the study, as a proxy for verbal ability and results indicate that children’s scores fell within the average range for their age (M = 100.36; SD = 14.79).

While the proportion of students performing in the at-risk range on component reading skills was still greater than the expected 25% there was a significant improvement across all skills with the notable exception of decoding fluency (See Table 7). Taken together, the results indicate that a significant proportion of students (63.7%) continued to be at risk in relation to same age peers in one or more component reading skill (including PA, Word Reading, Decoding, Word Reading Fluency, and Decoding Fluency) two years after the return to regular instruction.

**Table 8**

*Descriptive Statistics for Study 2*

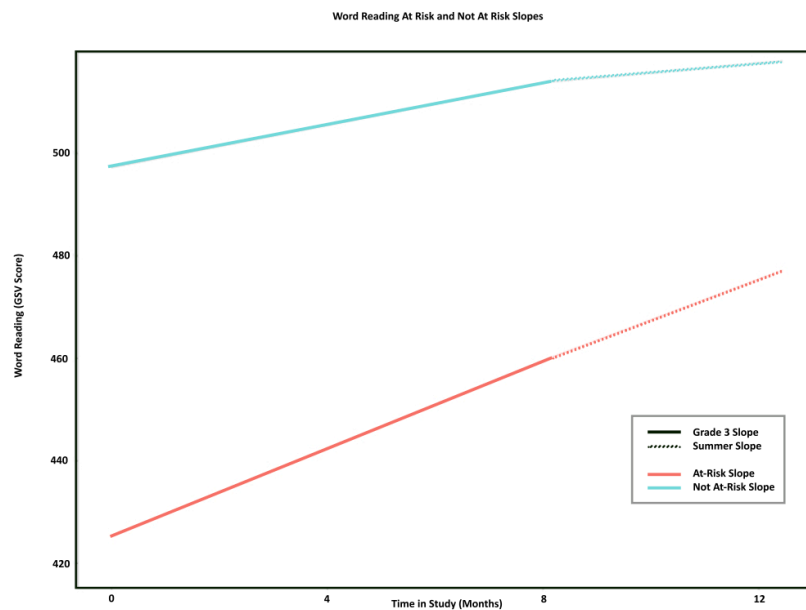
Measures	Standard Score Mean <sup>a</sup>	Standard Deviation <sup>2</sup>	Minimum	Maximum	Proportion at Risk <sup>b</sup>
Vocabulary <sup>c</sup>	100.36	14.82	65	130	19%
Phonological Awareness					
Wave 1 <sup>d</sup>	90.27	13.32	55	125	52%
Wave 2 <sup>e</sup>	99.56	16.92	60	130	35%
Wave 3 <sup>f</sup>	96.22	16.70	60	135	41%
Word Reading					
Wave 1 <sup>d</sup>	88.81	17.99	45	128	50%
Wave 2 <sup>e</sup>	94.17	17.04	52	125	33%
Wave 3 <sup>f</sup>	96.12	16.69	52	138	33%
Decoding					
Wave 1 <sup>d</sup>	85.99	14.42	63	125	62%
Wave 2 <sup>e</sup>	92.35	15.65	62	130	44%
Wave 3 <sup>f</sup>	93.59	15.39	62	130	41%
Word Reading Fluency					
Wave 1 <sup>d</sup>	84.73	18.34	39	131	62%
Wave 2 <sup>e</sup>	97.16	17.85	40	134	29%
Wave 3 <sup>f</sup>	92.56	15.25	44	137	41%
Decoding Fluency					
Wave 1 <sup>d</sup>	81.22	20.68	39	128	63%

Wave 2 <sup>e</sup>	94.61	15.74	61	132	40%
Wave 3 <sup>f</sup>	91.44	16.36	40	133	45%

*Note.* <sup>a</sup>Norm Referenced Standard Score Mean=100; Standard Deviation=15, <sup>b</sup>Scoring  $\leq 25^{\text{th}}$  Percentile, <sup>c</sup>Vocabulary measure only collected one time at participants 1<sup>st</sup> time in study, <sup>d</sup>Computed on a sample of 214, <sup>e</sup>Computed on a sample of 210, <sup>f</sup>Computed on a sample of 216.

### Recovery From COVID Learning Loss

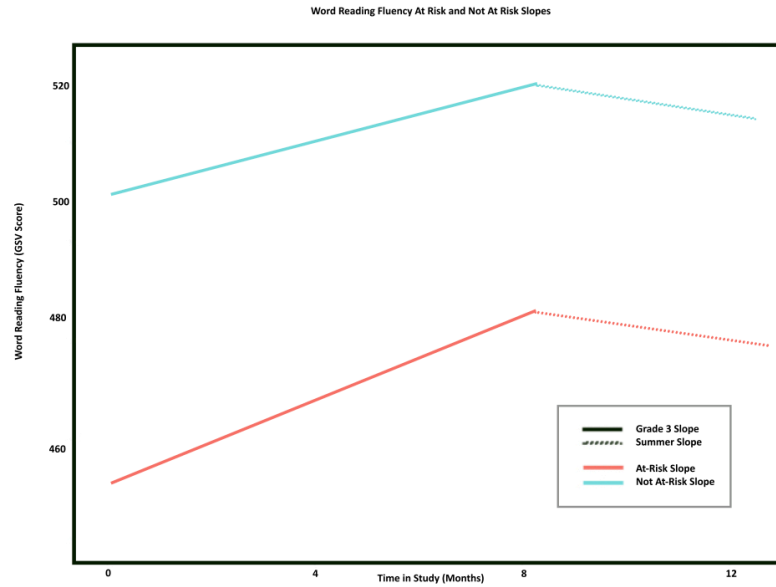
To further explore the development of reading skills over time, we employed spline models to chart the trajectory of skill acquisition across both Grade 3 and the summer, independently (see Figure 5, for example). The key advantage of spline models is that they can handle more complex relationships in the data where there are piecewise-linear trends by fitting different slopes to different segments while still ensuring that the transition between these slopes is smooth (Ruppert, et al., 2003). This makes splines a powerful tool for modelling more flexible and nuanced relationships that linear models cannot capture (Ruppert, et al., 2003). As expected, each component reading skill showcased significant gains across the school year. Rates of skill acquisition across Grade 3 were also significantly moderated by whether students were identified as at-risk in the respective component reading skill at baseline. That is, while at-risk students scored significantly lower at baseline on each reading skill, they also gained more competency each month, relative to not at-risk students, for every reading skill (see Figure 5, for example).

**Figure 5***Word Reading Slopes by Risk*

Contrary to the literature and our hypothesis, a summer slump was not evident across all skill development for at-risk and not at-risk students, but rather was only seen for the word reading fluency measures (see Figure 6). Word reading fluency did show the characteristic decline in performance across the summer (-0.95 units per month,  $p = 0.001$ ) while decoding fluency plateaued, showing no significant change (-0.51,  $p = 0.09$ ). Interestingly, word reading (see Figure 5) and nonsense word decoding performance saw unexpected, significant gains, across the summer, albeit not as large as those experienced during the school year (2.51 units gained per month relative to 3.12 units and 1.15 units gained per month relative to 1.75, respectively). Moreover, at risk students gained even more competency each month over the summer for word reading, relative to not at-risk students (3.52 units per month on average compared to 1.77 units). The results indicate that students who experienced the greatest impact of CLL were also the students who made the biggest gains. Recovery from CLL continued throughout the summer months except for word reading fluency (See Figure 6).

**Figure 6**

*Word Reading Fluency by Risk*



**Protective Factors**

We also examined whether select protective factors (i.e., phonological awareness and vocabulary) further modulated the rate of recovery from COVID-related learning losses. Contrary to expectations, phonological awareness did not significantly modulate trajectories of skill acquisition in either at-risk or not at-risk students with the exception of word reading fluency (See Table 8). For at-risk students within the word reading fluency model, unit increases in phonological awareness were associated with more significant gains over the school year (0.16,  $p = 0.001$ ). This did not continue over the summer months because word reading fluency was the only skill that declined over the summer representing a significant SLL for both at-risk and not-at risk students.

**Table 9**

*Phonological Awareness & Word Reading Fluency Spline Model by Risk*

Predictors	Estimates	CI	p
(Intercept)	518.42	512.58 – 524.25	<b>&lt;0.001</b>
Grade 3 slope	2.57	1.96 – 3.18	<b>&lt;0.001</b>
Summer slope	-1.62	-2.93 – -0.31	<b>0.017</b>
PA WRF c	0.08	-0.60 – 0.77	0.814
Risk WRF1	-35.46	-42.20 – -28.72	<b>&lt;0.001</b>
Grade 3 Slope × PA WRF c	-0.05	-0.12 – 0.02	0.140

Summer slope × PA WRF c	0.05	-0.10 – 0.21	0.496
Grade 3 Slope × Risk WRF1	0.75	0.05 – 1.45	<b>0.038</b>
PA WRF c × Risk WRF1	2.42	1.50 – 3.35	<b>&lt;0.001</b>
Summer slope × Risk WRF1	0.92	-0.59 – 2.43	0.238
(Grade 3 Slope × PA WRF c) × Risk WRF1	0.16	0.07 – 0.26	<b>0.001</b>
(Summer slope × PA WRF c) × Risk WRF1	-0.15	-0.36 – 0.07	0.184

**Random Effects**

$\sigma^2$	92.02
$\tau_{00 \text{ ID}}$	242.62
$\tau_{11 \text{ ID.TIS1m}}$	0.44
$\rho_{01 \text{ ID}}$	0.40
ICC	0.71
$N_{\text{ID}}$	214
Observations	561
Marginal $R^2$ / Conditional $R^2$	0.628 / 0.892

Note: TISm = Time in study in months, TIS1 = grade 3 slope, TIS2 = summer slope. PA = Phonological Awareness, WRF = Word Reading Fluency

Similar to the phonological awareness models, vocabulary performance at baseline was largely unassociated with the rate of skill acquisition over time (see appendix A for supplemental tables). The only exception to this was a significant modulating effect of vocabulary on rate of skill acquisition in word reading across the summer for at-risk students; however, the effect was in the unexpected direction (-0.29,  $p = 0.016$ ), with higher vocabulary being associated with shallower learning slopes across the summer for at-risk students (See Table 9). Overall, PA and Vocabulary did not significantly predict growth or acquisition of skills overtime and revealed that there was no significant difference in the rate or recovery for students from differing demographic populations (i.e., gender, SES, program of instruction).

**Table 10 Vocabulary & Word Reading Spline Model by Risk**

<i>Vocabulary &amp; Word Reading Spline Model by Risk</i>			
Predictors	Estimates	CI	p
(Intercept)	509.37	503.46 – 515.28	<b>&lt;0.001</b>
Grade 3 slope	2.03	1.51 – 2.54	<b>&lt;0.001</b>
Summer slope	1.54	0.62 – 2.47	<b>0.001</b>
Vocab WR c	1.52	0.59 – 2.45	<b>0.002</b>
Risk WR1	-50.82	-58.89 – -42.75	<b>&lt;0.001</b>
Grade 3 slope × Vocab WR c	-0.01	-0.09 – 0.07	0.892

Summer slope × Vocab WR c	0.07	-0.07 – 0.21	0.334
Grade 3 slope × Risk WR1	2.41	1.71 – 3.12	<b>&lt;0.001</b>
Vocab WR c × Risk WR1	0.97	-0.48 – 2.42	0.191
Summer slope × Risk WR1	1.92	0.60 – 3.23	<b>0.005</b>
(Grade 3 slope × Vocab WR c) × Risk WR1	0.04	-0.08 – 0.17	0.503
(Summer slope × Vocab WR c) × Risk WR1	-0.29	-0.53 – -0.06	<b>0.016</b>
<b>Random Effects</b>			
$\sigma^2$	108.77		
$\tau_{00 \text{ ID}}$	615.65		
$\tau_{11 \text{ ID.TIS1m}}$	1.78		
$\rho_{01 \text{ ID}}$	0.11		
ICC	0.85		
$N_{\text{ID}}$	214		
Observations	576		
Marginal $R^2$ / Conditional $R^2$	0.636 / 0.947		

*Note:* TISm = Time in study in months, TIS1 = Grade 3 slope, TIS2 = Summer slope, Vocab = Vocabulary, WR = Word Reading

### Coupling Analyses

We further investigated whether PA or Vocabulary performance were associated with reading skill level independent of time. We found that both PA and Vocabulary predicted skill level in all outcome reading measures at baseline regardless of risk (see paper 1). Similarly, for all students, regardless of risk, unit increases in PA were also associated with better performance in word reading and decoding fluency measures at the end of Grade 3. As an additional probe of the potential protective effects of time-varying predictors like PA, we also investigated within-person patterns of association between PA and component reading skill performance. These coupling models provide a rigorous within-person examination of whether unit increases in PA are systematically linked to changes in each component reading skill performance (See Appendix A Table 16). While these models no longer focus on learning acquisition rate over time, they provide a preliminary analysis of the potential mechanistic link between PA and component reading skills. Results indicated that PA did share systematic within-person coupling associations for at risk students on measures of decoding fluency (0.62,  $p = 0.014$ ). Specifically, for each unit increase in PA, above an individual's own personal mean,

there was a corresponding 0.62 unit increase in decoding fluency performance relative to not at-risk students. No systematic within-person associations were indicated for the not-at-risk students on any component reading skills.

Unlike the PA models, the protective influence of vocabulary on end-of-Grade-3 performance was less pronounced. Specifically, vocabulary was only a significant predictor of word reading performance, and this effect was between at-risk and not at-risk students (1.52,  $p = 0.002$ : See Table 9). When it comes to component reading skills at the word level, the results suggest that overall, higher PA is a protective factor for at risk students, whereas vocabulary had a varying impact on reading skills.

### **Risk Factors**

Lastly, we were interested in exploring if typical risk factors like SES and cultural and linguistic differences impact the rate of recovery from COVID learning loss. Given the small sample size of Indigenous and ELL students there was not enough statistical power to perform a 2 or 3 level model. However, at baseline the results indicate that our Indigenous students were performing worse on all reading variables than non-Indigenous kids. The analysis further indicated no significant differences between academic peers in English and French immersion programs, nor was there a notable difference based on socio-economic status. Although schools could serve as a potential third-level influence on data dependence—where students might be more similar to peers within the same school than across different schools—the intraclass correlation coefficients calculated for the three-level models showed that less than 1% of the variance in the outcomes could be attributed to school-level differences. This suggests that COVID was a leveling agent and impacted students' recovery equally regardless of program of instruction or SES.

### **Discussion**

Students who have not developed proficient reading skills by Grade 4 are more likely to experience academic difficulties that extend into adolescence and adulthood (National Early Literacy

Panel, 2008; Ritchey et al., 2013), making it critical to examine how COVID disruptions impacted early reading development. The findings from our study highlight that while a significant number of students remain at-risk for reading difficulties, when tested in the fall of Grade 4, there is encouraging evidence of slow recovery. While this may in part be evidence of students' regression towards the mean, it might also represent student resilience and recovery from CLL. Students with the greatest initial gaps showed the largest gains in skill acquisition, with growth continuing across the summer (see Figure 5). This suggests that the skills acquired during the academic year were likely consolidating into long-term memory. Contrary to expectations, no overall "summer slump" was evident for most reading skills, with the exception of word reading fluency (see Figure 6) further supporting the premise that skills learned over the school year were beginning to be consolidated into long term memory, but without consistent retrieval and practice over the summer fluency declined. Interestingly, some students, particularly those initially at risk, made significant gains over the summer, specifically in word reading and nonsense word decoding, challenging traditional assumptions of summer learning loss (Alexander et al., 2007, Vaughn et al., 2005).

One of the most notable findings from this study is the limited influence of traditional risk factors, such as SES and language of instruction, on students' recovery from learning losses. Although SES is a well-established predictor of academic achievement (Boon, 2008, Buckingham, et al., 2013, 2014; Dolean, et al., 2019) our results indicate that students across all SES levels demonstrated comparable rates of recovery. Similarly, no significant differences emerged between students in English and French immersion programs, challenging assumptions about the differential impact of instructional language on reading development. For Indigenous students, baseline results showed lower performance across all reading measures compared to non-Indigenous peers; however, their recovery rates in subsequent waves did not significantly differ from other at-risk students. While vocabulary and phonological awareness predicted reading outcome variables and served as both protective and risk

factors depending on performance, vocabulary did not moderate the rate of recovery from CLL, whereas phonological awareness played a nuanced role in recovery for students initially identified as at-risk.

The findings also indicate that while students are gradually recovering from CLL, the process is still ongoing, with a significant proportion remaining within the at-risk range when compared to pre-pandemic norms. Two years after returning to regular instruction and three years post-lockdown, 63.7% of students continue to exhibit persistent reading difficulties, reflecting concerns raised by other studies on the enduring nature of COVID-related literacy losses (U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, n.d.). Despite some progress, many students are still not meeting age-expected reading levels, suggesting that regular learning trajectories are not naturally resumed without systemic changes and targeted interventions. Our study highlights the need for continued support, as a substantial number of students still require intervention or remedial services as of Grade 4. Resilience research suggests that the developmental timing of adversity can significantly influence outcomes, often leading to more pronounced and long-lasting effects depending on when the disruption occurs (Masten 2014, 2020). This appears to be especially relevant for students who were in Grade 1 when pandemic lockdowns began, as this period is important for acquiring foundational reading skills. Findings from our study, along with recent data from the National Assessment of Educational Progress (NAEP), support the notion that early disruptions to literacy development have had a cascading impact on later academic achievement (U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, n.d.). Similar to our study, these students were in Grade 1 during the 2019/2020 school year and were at a pivotal stage in their literacy development, transitioning from emergent reading to more complex word recognition skills (Ehri, 2005, 2020). Disruptions at this stage are particularly detrimental because they hinder the acquisition of basic skills needed to support future learning, making it more challenging for students to catch up (Stanovich, 1986) even after returning to regular instruction. Together these findings challenge

the assumption that children are inherently resilient and capable of rebounding (or bouncing back) from adversity. Importantly our study reveals that without targeted efforts, recovery for this cohort of students has been significantly prolonged - taking up to four times longer to recoup the six months of learning lost during the initial lockdowns.

### **Limitations**

This study has several limitations that should be acknowledged. First, the small sample size ( $n = 247$ ) and limited number of participating schools ( $n = 5$ ) constrained the ability to model more complex, three-level multilevel analyses (MLM) that could capture variations across schools and classrooms. As a result, it may be difficult to generalize the findings to a broader student population or to capture the full extent of variability at the school level. Additionally, the study included a relatively small number of English Language Learners (ELL) and Indigenous students, which limited our capacity to conduct subgroup analyses and fully examine potential differences in recovery trajectories for these populations.

A second limitation of our study is the examination of SES as a factor, as the partner school district intentionally selected predominantly middle-class/middle-income schools to investigate CLL. There was already a concern pre-pandemic regarding reading achievement for schools with the highest enrollment of culturally and linguistically diverse populations. As such, preexisting reading concerns would have skewed the investigation into pandemic-related learning losses. Nevertheless, these culturally and linguistically diverse schools also happen to be in lower income neighborhoods consequently limiting the power and interpretability of the SES statistical modeling.

Another limitation is the restricted geographical scope of the study, as all participating schools were located within a single region in British Columbia. This regional focus reduces the generalizability of the findings to other educational contexts, particularly those with differing demographics, instructional approaches, levels of pandemic disruption, or COVID-19 academic recovery plans. Future research should consider larger, more diverse samples across multiple regions to provide a more

comprehensive understanding of recovery patterns and the factors influencing reading development following pandemic-related learning losses. Despite these limitations, the study offers important insights into the ongoing effects of learning disruptions and the need for targeted interventions to support at-risk students.

### **Conclusion**

This study contributes to the growing body of research on the long-term impacts of the COVID-19 pandemic on students' reading development, providing new insights into the recovery trajectories of at-risk and not-at-risk students. While this study provides evidence of significant recovery following COVID-19 learning losses, a substantial proportion of students remain at risk, in one or more component reading skills. Overall, the results suggest that a one-size-fits-all approach to recovery may be insufficient, and targeted, skill-specific interventions are necessary to ensure that all students, especially those most affected by the pandemic, can reach their full reading potential. The findings from this research offer crucial insights into the current educational landscape and highlight the need for systems, and policies aimed at bridging the learning disparities that disruptions to education can have on primary students' learning.

If left unaddressed, literacy challenges by Grade 4 often lead to lifelong difficulties, contributing to broader societal impacts (National Early Literacy Panel, Lonigan et al., 2008; Ritchey et al., 2013). Approximately one in six Canadians are functionally illiterate, (Statistics Canada, et al., 2013), with nearly 50% possessing low literacy skills that limit their ability to navigate modern work environments and engage with complex texts (OECD, 2019). These deficits not only hinder individual opportunities but also restrict full participation in a rapidly evolving work environment, emphasizing the urgent need for targeted interventions and support in early literacy to prevent long-term consequences for both individuals and society (OECD, 2019). Consequently, further research is required to continue tracking this cohort's progress, determine the time required to fully regain academic standing, and assess whether

complete recovery to pre-pandemic levels is feasible or if more intensive, long-term support strategies are necessary to avoid them becoming adults with low literacy skills.

### **Chapter V: Conclusion**

This chapter provides a summary conclusion to the series of studies by outlining the key findings in the context of the research goals and questions, emphasizing their significance and contributions to the field. Additionally, it will examine the limitations of the studies and outlines potential directions for future research endeavors. This multi-paper dissertation explored several research questions pertaining to whether educational disruptions have a lasting impact on the development and acquisition of foundational reading skills. The first study investigated to what extent students were experiencing reading delays post pandemic, which component literacy skills were most delayed, and what proportion of students were considered at-risk in one or more component reading skills. The second study is a longitudinal investigation that built upon the initial study, following the same cohort of students and assessing their literacy skills across three separate data collection periods. This research examined the various risk and protective factors influencing literacy learning loss in primary students and their subsequent recovery following pandemic-related disruptions.

The research is grounded in several theoretical frameworks, including Information Processing Theory (Atkinson & Shiffrin, 1968), risk and resiliency theories (Bronfenbrenner & Morris, 2006; Masten, 2014; 2020), the Direct and Indirect Effects Model of Reading (DIER) (Kim, 2017, 2020), and Phase Theory of Reading Development (Ehri, 2005, 2020). These frameworks provide a foundation for understanding learning loss, the complex and interactive influences on reading, and the stages of reading development during which children typically consolidate essential cognitive processes and skills. Information Processing Theory highlights how disruptions might impact the encoding, storage, and retrieval of reading-related information. The DIER model emphasizes the intricate interplay between direct influences, such as phonological awareness, and indirect influences, like oral language skills, in

shaping reading outcomes. While, Ehri's Phase Theory delineates the stages through which children typically progress as they develop reading proficiency, illustrating how pandemic-related disruptions might have interrupted these critical phases. Furthermore, risk and resiliency theories provide insights into which factors have influenced the recovery of skills after the return to regular instruction. Together, these frameworks not only help explain the observed learning losses but also guide our understanding of the recovery of skills post pandemic.

The findings confirm that the interruptions caused by COVID-19 had a profound and lasting impact on children's reading development. Three years post-pandemic, our data indicates that the majority of students have not returned to the pre-pandemic reading proficiency levels expected for their age. Despite the perception that children are inherently resilient and could quickly resume their academic trajectory, the recovery progress has been slow and continues to evolve. The notion that young children could pick up where they left off has been challenged by the reality that over 63 % of students remain at risk in one or more foundational reading skills at the end of Grade 4. Students who were most at risk and had the greatest room for improvement demonstrated the most significant progress. Interestingly, the rate of recovery from sustained learning losses were not mitigated by typical protective factors such as PA, vocabulary or SES. This prolonged and uneven recovery process could be described as education's version of "Long-COVID," reflecting the enduring and multifaceted challenges that continue to affect students' academic trajectories.

This series of studies is subject to several limitations that should be considered when interpreting the findings. First, the research includes only three waves of data collection, which may not fully capture the trajectory of reading development or the long-term effects of the disruptions under investigation. This limited temporal scope could result in an incomplete understanding of the trends and patterns in literacy recovery. Second, the study's sample is drawn from only five schools, which restricts the statistical power at level 3 in multi-level modeling (MLM). This limitation may reduce the reliability

and generalizability of the findings, particularly when interpreting the effects at the school level. Additionally, the schools involved are predominantly middle-income, which constrains the analysis of socioeconomic status (SES) as a protective or risk factor. The homogeneity of SES within the sample limits the ability to draw robust conclusions about the role of SES in literacy outcomes. Finally, the study is conducted within a mid-sized suburban school district in British Columbia, Canada, which may limit the applicability of the findings to other contexts, particularly those in different geographical regions or with different demographic compositions. These limitations highlight the need for cautious interpretation and suggest that further research with more diverse and expansive samples is necessary to enhance the generalizability of the results.

Further research is needed to track this cohort of students beyond Grade 4 and into high school in order to gain a better understanding of the long-term effects of COVID disruptions on reading and overall academic achievement. Such research would allow for the identification of sustained or evolving patterns in academic recovery and provide critical insights into whether students continue to rebound naturally over time. Additionally, it would help determine the full extent of the recovery timeline and highlight areas requiring prolonged support. A parallel focus should be placed on exploring and evaluating targeted interventions designed to address disparities exacerbated by these disruptions, ensuring that students are adequately supported in meeting expected reading benchmarks and achieving equitable academic outcomes.

This research sheds light on the long-term impacts of formal educational disruptions, (such as those caused by the pandemic, climate disasters, war, and other crises,) on the development of reading skills in primary students. It is crucial to consider that these disruptions can have far-reaching consequences, potentially hindering literacy acquisition in ways that extend beyond the immediate crisis period. The cumulative effects of interrupted instruction, trauma, and the loss of stable learning environments can lead to delays in mastering foundational reading skills, which may persist throughout

a child's educational trajectory (National Early Literacy Panel, Lonigan et al., 2008; Ritchey et al., 2013).

An understanding of the CLL phenomena is vital for mitigating the impact of future disruptions, empowering educators to enhance students' resilience in maintaining and restoring their literacy skills in the face of unforeseen challenges.

This research reveals that the recovery from pandemic-related educational disruptions is neither automatic nor uniform, challenging assumptions about resilience in young children. As it pertains to literacy our data suggests that children are susceptible to lasting reading delays when disruptions take place at critical phases in their reading development. Notably, British Columbia lacked a mandated literacy recovery plan in the aftermath of COVID-19, and the reliance on an ad hoc approach has proven insufficient in meeting the needs of young learners disproportionately impacted by the pandemic. A more cohesive, strategically implemented framework is essential to effectively support these students and mitigate long-term educational disparities. The findings call for a reimagining of educational systems to address structural inequities and provide sustained, evidence-based support for at-risk learners. By understanding these disruptions as catalysts for systemic reflection, educators and policymakers have the opportunity to create more robust frameworks that can withstand future crises while mitigating the negative long-term consequences associated with literacy-based learning difficulties.

### References

- Aaron, P. G., Joshi, R. M., Ayotollah, M., Ellsberry, A., Henderson, J., & Lindsey, K. (1999). Decoding and sight-word naming: are they two independent components of word-recognition skill? *Reading and Writing: An Interdisciplinary Journal*, *11*, 89–127.
- Aguaded, I., Vizcaíno-Verdú, A., García-Prieto, V., & de-Casas-Moreno, P. (2023). The impact of post-pandemic learning loss on education development: A systematic review. *Review of Communication Research*, *11*, 173–184. <https://doi.org/10.5680/RCR.V11.7>
- Alexander, K. L., Entwisle, D. R., & Olson, L. S. (2001). Schools, achievement, and inequality: A seasonal perspective. *Educational Evaluation and Policy Analysis*, *23*(2), 171–191. <https://doi.org/10.3102/01623737023002171>
- Alexander, K. L., Entwisle, D. R., & Olson, L. S. (2007). Lasting consequences of the summer learning gap. *American Sociological Review*, *72*(2), 167–180. <https://doi.org/10.1177/000312240707200202>
- Almeida, D. M., & Wong, J. D. (2009). Life transitions and daily stress processes. In G. H. Elder & J. Z. Giele (Eds.), *The craft of life course research* (pp. 141–162). Guilford.
- Alsius, A., Paré, M., & Munhall, K. G. (2020). The contribution of serial order short-term memory and long-term learning to reading acquisition: A longitudinal study. *Multisensory Research*, *31*(1–2), 111–144. <https://doi.org/10.1163/22134808-00002565>
- Andrew, A., Cattan, S., Costa Dias, M., Farquharson, C., Kraftman, L., Krutikova, S., Phimister, A., & Sevilla, A. (2020). Inequalities in children’s experiences of home learning during the COVID-19 lockdown in England\*. *Fiscal Studies*, *41*(3), 653–683. <https://doi.org/10.1111/1475-5890.12240>
- Angrist, N., De Barros, A., Bhula, R., Chakera, S., Cummiskey, C., DeStefano, J., Floretta, J., Kaffenberger, M., Piper, B., & Stern, J. (2021). Building back better to avert a learning catastrophe: Estimating learning loss from COVID-19 school shutdowns in Africa and facilitating short-term and long-

- term learning recovery. *International Journal of Educational Development*, *84*, 102397.  
<https://doi.org/10.1016/j.ijedudev.2021.102397>
- Asadullah, M. N., Bouhlila, D. S., Chan, S., Draxler, A., Ha, W., Heyneman, S. P., Luschei, T. F., Semela, T., & Yemini, M. (2023). A year of missed opportunity: Post-Covid learning loss – A renewed call to action. *International Journal of Educational Development*, *99*, 102770. <https://doi.org/10.1016/j.ijedudev.2023.102770>
- Ashbaker, M. H., & Swanson, H. L. (1996). Short-term memory and working memory operations and their contribution to reading in adolescents with and without learning disabilities. *Learning Disabilities Research and Practice*, *11*(4), 206–213
- Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In *Elsevier eBooks* (pp. 89–195). [https://doi.org/10.1016/s0079-7421\(08\)60422-3](https://doi.org/10.1016/s0079-7421(08)60422-3)
- Atteberry, A., & McEachin, A. (2020). School's out: The role of summers in understanding achievement disparities (EdWorkingPaper:20–82). <https://doi.org/10.26300/2mam-bp02>
- August, D., & Shanahan, T. (2006). Developing literacy in second-language learners: Report of the National Literacy Panel on Language-Minority Children and Youth. Mahwah, NJ: Lawrence Erlbaum Associates.
- Aurini, J., & Davies, S. (2021). COVID-19 school closures and educational achievement gaps in Canada: Lessons from Ontario summer learning research. *Canadian Review of Sociology/Revue Canadienne De Sociologie*, *58*(2), 165–185. <https://doi.org/10.1111/cars.12334>
- Au-Yeung, K., Hipfner-Boucher, K., Chen, X., Pasquarella, A., D'Angelo, N., & Deacon, S. H. (2015). Development of English and French language and literacy skills in EL1 and EL French Immersion students in the early grades. *Reading Research Quarterly*, *50*(2), 233–254. <https://doi.org/10.1002/rrq.95>
- Babu, S. C., Gajanan, S. N., & Hallam, J. (2017). Methods of program evaluation. In *Elsevier eBooks* (pp. 205–230). <https://doi.org/10.1016/b978-0-12-800878-2.00011-6>

- Bacher-Hicks, A., Goodman, J., & Mulhern, C. (2021). Inequality in household adaptation to schooling shocks: COVID-induced online learning engagement in real time. *Journal of Public Economics*, 193, 104345. <https://doi.org/10.1016/j.jpubeco.2020.104345>
- Backman, J. (1984). Acquisition and use of spelling-sound correspondences in reading. *Journal of Experimental Child Psychology*, 38(1), 114.
- Bailenson, J. N. (2021). Nonverbal overload: A theoretical argument for the causes of Zoom fatigue. *Technology, Mind, and Behavior*, 2(1).
- Bailey, D.H., Duncan, G.J., Murnane, R., & Au Yeung Achievement gaps in the wake of COVID-19 (2021) *Educational Researcher*, Vol. 50 No. 5, pp. 266–275 DOI: 10.3102/0013189X211011237
- BC Ministry of Education. (n.d.). Building Student Success - B.C. curriculum. <https://curriculum.gov.bc.ca>
- BC Ministry of Education. (n.d.) *Français langue seconde – immersion 3*. Building Student Success - B.C. curriculum. <https://curriculum.gov.bc.ca/curriculum/fral/3/core>
- British Columbia Ministry of Education. (2021). *K-12 education recovery plan*. Government of British Columbia. <https://files.eric.ed.gov/fulltext/ED613802.pdf>
- Belot, M., & Webbink, D. (2010). Do teacher strikes harm educational attainment of students? *Labour*, 24(4), 391–406. <https://doi.org/10.1111/j.1467-9914.2010.00494.x>
- Benner, A. D., & Mistry, R. S. (2020). Child development during the COVID-19 pandemic through a life course theory lens. *Child Development Perspectives*, 14(4), 236–243. <https://doi.org/10.1111/cdep.12387>
- Ben-Yehudah, G., & Fiez, A. (2007). Development of verbal working memory. In D. Coch, W. Fischer, & G. Dawson (Eds.), *Human Behaviour Learning and the Developing Brain* (pp. 301–328). Guilford Press.
- Betthäuser, B. A., Bach-Mortensen, A., & Engzell, P. (2023). A systematic review and meta-analysis of the evidence on learning during the COVID-19 pandemic. *Nature Human Behaviour*, 7(3), 375–385. <https://doi.org/10.1038/s41562-022-01506-4>

- Bernstein, L. E. (2012). Visual speech perception. In E. Vatikiotis-Bateson, G. Bailly, & P. Perrier (Eds.), *Audiovisual Speech Processing* (pp. 21–39). Cambridge University  
<https://doi.org/10.1017/CBO9780511843891.004>
- Boulay, M., & McChesney, E. (2021). What will summer look like? summer learning loss and COVID-19 learning gaps. *Children and Libraries, 19*(2), 3. <https://doi.org/10.5860/cal.19.2.3>
- Boulet, L. A., Harrison, G., & Macdonald, S. (2023), *The Influence of Vocabulary and Phonological Processing on Third Grade Pandemic Reading Skills: Comparisons among Students in English and French Immersion Programs*. Canadian Psychological Association 2023 Annual National Convention. Toronto, Ontario, Canada.
- Bradley, L., & Bryant, P.E. (1978). Differences in auditory organization as a possible cause of reading backwardness. *Nature, 271*, 746–747.
- Bradley, L., & Bryant, P.E. (1983). Categorizing sounds and learning to read - A causal connection. *Nature, 301*, 419–421.
- Buckingham, J., Beaman, R., & Wheldall, K. (2014). Why poor children are more likely to become poor readers: The early years. *Educational Review, 66*(4), 428–446. <https://doi.org/10.1080/00131911.2013.795129>.
- Buckingham, J., Wheldall, K., & Beaman-Wheldall, R. (2013). Why poor children are more likely to become poor readers: The school years. *Australian Journal of Education, 57*(3), 190–213.  
<https://doi.org/10.1177/0004944113495500>
- Burkam, D. T., Ready, D. D., Lee, V. E., & LoGerfo, L. F. (2004). Social class differences in summer learning between kindergarten and first grade: Model specification and estimation. *Sociology of Education, 77*(1), 1–31. <https://doi.org/10.1177/003804070407700101>
- Burkam, D. T., Ready, D. D., Lee, V. E., & LoGerfo, L. F. (2004). Social class differences in summer learning between kindergarten and first grade: Model specification and estimation. *Sociology of Education, 77*(1), 1–31. <https://doi.org/10.1177/003804070407700101>
- Cain, K. (2009). Making sense of text: Skills that support text comprehension and its development. *Perspectives on Language and Literacy, 35*, 11–14.

- Cain, K, Nation, K., Snowling, M. J., Hulme, C. (2022). Children's reading comprehension difficulties. In Snowling, M. J., Hulme, C., & Nation, K. (2022). *The science of reading: A handbook* (2nd ed., pp. 298–322). (Wiley Blackwell Handbooks of Developmental Psychology) (2nd ed.). John Wiley & Sons, Ltd.
- Capovilla, A. G. S., & Dias, N. M. (2007). Desenvolvimento de estratégias de leitura no ensino fundamental e correlação com nota escolar. *Psicologia em Revista, 13*(2), 363-363.
- Carlisle, J. (2000). Awareness of the structure and meaning of morphologically complex words: Impact on reading. *Reading & Writing, 12*(3-4), 169–190. <https://doi.org/10.1023/A:1008131926604>
- Cárnio, M. S., Vosgrau, J. S., & Soares, A. J. C. (2017). The role of phonological awareness in reading comprehension. *Revista CEFAC, 19*, 590-600.
- Chall J.S. (1983). *Learning to read: The great debate* (2nd ed.) New York: McGraw-Hill. Chatzoglou, E., Fishstrom, S., Payne, S. B., Andress, T. T., & Vaughn, S. (2023). The footprint of the COVID-19 pandemic in reading performance of students in the U.S. with and without disabilities. *Research in Developmental Disabilities, 140*, 104585. <https://doi.org/10.1016/j.ridd.2023.104585>
- Chen, C. Y., Pedersen, S., & Murphy, K. L. (2011). Learners' perceived information overload in online learning via computer-mediated communication. *Research in Learning Technology, 19*(2).
- Cordini, M., & de Angelis, G. (2021). Families between care, education and work: The effects of the pandemic on educational inequalities in Italy and Milan. *European Journal of Education*. Published. <https://doi.org/10.1111/ejed.12483>
- Cooper, H., Nye, B., Charlton, K., Lindsay, J., & Greathouse, S. (1996). The effects of summer vacation on achievement test scores: A narrative and meta-analytic review. *Review of Educational Research, 66*(3), 227–268. <https://doi.org/10.3102/00346543066003227>
- Cruz, J., Mendes, S. A., Marques, S., Alves, D., & Cadime, I. M. D. (2022). Face-to-face versus remote: Effects of an intervention in reading fluency during COVID-19 Pandemic. *Frontiers in Education, 6*. <https://doi.org/10.3389/feduc.2021.817711>

- Deacon, S. H., & Kirby, J. R. (2004). Morphological awareness: Just “more phonological”? The roles of morphological and phonological awareness in reading development. *Applied Psycholinguistics*, 25(2), 223–238. <https://doi.org/10.1017/S0142716404001110>
- Dehaene, S. (2009). *Reading in the brain: the new science of how we read*. Penguin Books.
- Di Pietro, G. (2023). The impact of Covid-19 on student achievement: Evidence from a recent meta-analysis. *Educational Research Review*, 39, 100530. <https://doi.org/10.1016/j.edurev.2023.100530>
- Domingue, B. W., Dell, M., Lang, D., Silverman, R. D., Yeatman, J. D., & Hough, H. (2022). The effect of COVID on oral reading fluency during the 2020–2021 academic year. *AERA Open*, 8, 233285842211202. <https://doi.org/10.1177/23328584221120254>
- Donnelly, R., & Patrinos, H. A. (2021). Learning loss during Covid-19: An early systematic review. *Prospects*, 51(4), 601–609. <https://doi.org/10.1007/s11125-021-09582-6>
- Dorn, E., Hancock, B., Sarakatsannis, J., & Viruleg, E. (2020). Learning loss during Covid-19: An early systematic review. PROSPECTS.
- Ehri, L. C. (2020). The science of learning to read words: A case for systematic phonics instruction. *Reading Research Quarterly*, 55(S1), S45–S60. <https://doi.org/10.1002/rrq.334>
- Ehri, L. C. (2017). Reconceptualizing the development of sight word reading and its relationship to recoding. In *Reading acquisition* (pp. 107-143). Routledge.
- Ehri, L. C. (2014). Orthographic mapping in the acquisition of sight word reading, spelling memory, and vocabulary learning. *Scientific Studies of Reading*, 18(1), 5–21. <https://doi.org/10.1080/10888438.2013.819356>
- Ehri, L. C. (2013). Orthographic mapping in the acquisition of sight word reading, spelling memory, and vocabulary learning. *Scientific Studies of Reading*, 18(1), 5–21.
- Ehri, L. (2005a). Development of sight word reading: Phases and findings. In M. Snowling & C. Hulme (Eds.), *The science of reading: A handbook* (pp. 135–154). Malden, MA: Blackwell.
- Ehri, L. C. (2005b). Learning to read words: theory, findings, and issues. *Scientific Studies of Reading*, 9(2), 167–188. [https://doi.org/10.1207/s1532799xssr0902\\_4](https://doi.org/10.1207/s1532799xssr0902_4)

- Ehri L.C. (1991). Learning to read and spell words. In Rieben L., Perfetti C.A. (Eds.), *Learning to read: Basic research and its implications* (pp. 57-73).
- Ehri, L. C., & McCormick, S. (1998). Phases of word learning: Implications for instruction with delayed and disabled readers. *Reading & Writing Quarterly*, 14(2), 135–163.  
<https://doi.org/10.1080/1057356980140202>
- Engzell, P., Frey, A., & Verhagen, M. D. (2020). Learning inequality during the COVID-19 pandemic. SocArXiv. <https://ideas.repec.org/p/osf/socarx/ve4z7.html>
- Fauville, G., Luo, M., Queiroz, A. C., Bailenson, J. N., & Hancock, J. (2021). Zoom exhaustion & fatigue scale. *Computers in Human Behavior Reports*, 4, 100119.
- Flanigan, K., Solic, K., & Gordon, L. (2022). The “P” word revisited: 8 principles for tackling today’s questions and misconceptions about phonics instruction. *The Reading Teacher*, 76(1), 73–83.  
<https://doi.org/10.1002/trtr.2101>
- Fletcher, J. M., Francis, D. J., Foorman, B. R., & Schatschneider, C. (2021). Early Detection of Dyslexia Risk: Development of Brief, Teacher-Administered Screens. *Learning Disability Quarterly*, 44(3), 145–157
- Frenett, M., Frank, K., & Deng, Z. (2020). School closures and the online preparedness of children during the COVID-19 pandemic (vol. 103; Tech. Rep.). Statistics Canada.
- Frith U. (1985). Beneath the surface of developmental dyslexia. In Patterson K.E., Marshall J.C., Coltheart M. (Eds.), *Surface dyslexia: Neuropsychological and cognitive studies of phonological reading* (pp. 301-330). London: Erlbaum.
- Förster, N., Forthmann, B., Back, M. D., & Souvignier, E. (2022). Effects of the COVID-19 pandemic on reading performance of second grade children in Germany. *Reading and Writing*, 36(2), 289–315. <https://doi.org/10.1007/s11145-022-10379-y>
- Fuchs, D., Mock, D., Morgan, P. L., & Young, C. L. (2003). Responsiveness-to-intervention: Definitions, evidence, and implications for the learning disabilities construct. *Learning Disabilities Research & Practice*, 18(3), 157-171.

- Fuchs, L. S., Seethaler, P. M., Fuchs, L. S., & Espinas, D. R. (2023). Severe pandemic learning loss and the promise of remotely delivered intervention in students with comorbid reading and mathematics learning difficulty. *Journal of Learning Disabilities, 56*(4), 278–294.  
<https://doi.org/10.1177/00222194231170313>
- Furqon, F. (2013). Correlation between students' vocabulary mastery and their reading comprehension. *Journal of English and education, 1*(1), 68-80. Gazzaniga, M., Ivry, R. B., & Mangun, G. R. (2018). *Cognitive Neuroscience: Fifth International Student Edition*. W.W. Norton & Company.
- Gaillard, W. D., Balsamo, L., Ibrahim, Z., Sachs, B. C., & Xu, B. (2003). fMRI identifies regional specialization of neural networks for reading in young children. *Neurology, 60*(1), 94–100.  
<https://doi.org/10.1212/wnl.60.1.94>
- Gershenson, S., Jackowitz, A., & Brannegan, A. (2017). Are student absences worth the worry in U.S. primary schools? *Education Finance and Policy, 12*(2), 137–165.  
[https://doi.org/10.1162/EDFP\\_a\\_00207](https://doi.org/10.1162/EDFP_a_00207)
- Gierczyk, M., & Hornby, G. (2023). Summer learning loss: review of research and implications for remediation of post-pandemic learning loss. *Preventing School Failure, 67*(3), 132–140.  
<https://doi.org/10.1080/1045988x.2023.2204823>
- Gillon, G., McNeill, B., Scott, A., Denston, A., Wilson, L., Carson, K., et al. (2019). A better start to literacy learning: Findings from a teacher-implemented intervention in children's first year at school. *Reading and Writing, 32*, 1989–2012. <https://doi.org/10.1007/s11145-01809933-7>
- Gnaldi, M., Tomaselli, V., & Forcina, A. (2018). Ecological fallacy and covariates: New insights based on multilevel modelling of individual data. *International Statistical Review, 86*(1), 119-135.  
<http://doi.org/10.1111/insr.12244>
- Gore, J., Fray, L., Miller, D., Harris, J., & Taggart, W. (2021). The impact of Covid-19 on student learning in New South Wales primary schools: An empirical study. *The Australian Educational Researcher, 48*, 605–637.
- Gough P.B., Hillinger M.L. (1980). Learning to read: An unnatural act. *Bulletin of the Orton Society, 20*, 179-196

Gough, P. B. & Tunmer, W. E. (1986). Decoding, reading and reading disability. *Remedial and Special Education* 7(1), 6-10.

Government of British Columbia (n.d.) <https://curriculum.gov.bc.ca>

Grigorenko, E. L. (2006). Learning disabilities in juvenile offenders. *Child and Adolescent Psychiatric Clinics of North America*, 15, 353-37

Guilmette, T. J., Sweet, J. J., Hebben, N., Koltai, D., Mahone, E. M., Spiegler, B. J., Stucky, K., & Westerveld, M. (2020). American Academy of Clinical Neuropsychology consensus conference statement on uniform labeling of performance test scores. *The Clinical Neuropsychologist*, 34(3), 437–453. <https://doi.org/10.1080/13854046.2020.1722244>

Haeck, C., & Lefebvre, P. (2020). Pandemic school closures may increase inequality in test scores. *Canadian Public Policy*, 46(s1), S82–S87. <https://doi.org/10.3138/cpp.2020-055>

Hair, J. F., & Fávero, L. P. L. (2019). Multilevel modeling for longitudinal data: concepts and applications. *RAUSP Management Journal*, 54(4), 459–489. <https://doi.org/10.1108/rausp-04-2019-0059>

Halloran, C., Hug, C. E., Jack, R., & Oster, E. (2023). Post COVID-19 test score recovery: Initial evidence from state testing data. Illumina TPD EconLit - Unstructured.

Hanushek, E. A., & Woessmann, L. (2020). The economic impacts of learning losses. OECD.

Hillsdale, NJ: Erlbaum. Rayner, K., Foorman, B. R., Perfetti, C. A., Pesetsky, D., & Seidenberg, M. S. (2001). How psychological science informs the teaching of Reading. *Psychological Science in the Public Interest*, 2(2), 31–74. <https://doi.org/10.1111/1529-1006.00004>

Hogan, T. P., Catts, H. W., & Little, T. D. (2005). The relationship between phonological awareness and reading: implications for the assessment of phonological awareness. *Language, Speech & Hearing Services in Schools*, 36(4), 285–293. [https://doi.org/10.1044/0161-1461\(2005/029\)](https://doi.org/10.1044/0161-1461(2005/029))

Hoover, W., & Gough, P. (1990). The simple view of reading. *Reading & Writing*, 2(2), 127–160. <https://doi.org/10.1007/BF00401799>

Hoover, W. A., & Tunmer, W. E. (2018). The simple view of reading: Three assessments of its adequacy. *Remedial and Special Education*, 39(5), 304–312. <https://doi.org/10.1177/0741932518773154>

- Ichino, A., & Winter-Ebmer, R. (2004). The long-run educational cost of World War II. *Journal of Labor Economics*, 22, 57–87. <https://doi.org/10.1086/380403>
- Jenkins, J. R., Hudson, R. F., & Johnson, E. S. (2007). Screening for at-risk readers in a response to intervention framework. *School Psychology Review*, 36(4), 582–600. <https://doi.org/10.1080/02796015.2007.12087919>
- Jorm, A. F., & Share, D. L. (1983). An invited article: Phonological recoding and reading acquisition. *Applied psycholinguistics*, 4(2), 103-147.
- Joshi, R. M., & Aaron, P. G. (2000). The component model of reading: Simple view of reading made a little more complex. *Reading Psychology*, 21(2), 85-97.
- Joshi, M., & Aaron, P. G. (2012). Componential model of reading (CMR): Validation studies. *Journal of Learning Disabilities*, 45, 387–390. <https://doi.org/10.1177/0022219411431240>
- Kaminski, R. A., & Good, R. H. (1996). Toward a technology for assessing basic early literacy skills. *School Psychology Review*, 25(2), 215–227. <https://doi.org/10.1080/02796015.1996.12085812>
- Kaufman, A. S., & Kaufman, N. L. (2014). Kaufman test of educational achievement, third edition. Bloomington, MN: NCS Pearson.
- Kaufman, A. S., & Kaufman, N. L. (with Breaux, K. C.). (2014). Technical and interpretive manual Kaufman test of educational achievement, third edition. Bloomington, MN: NCS Pearson.
- Kidder, A. (2022, April 8). Pan-Canadian scan reveals large gaps in education recovery and renewal plans - People for Education. *People for Education*. <https://peopleforeducation.ca/pan-canadian-scan-reveals-large-gaps-in-education-recovery-and-renewal-plans/>
- Kim, Y.-S. G. (2017). Why the simple view of reading is not simplistic: Unpacking the simple view of reading using a direct and indirect effect model of reading (DIER). *Scientific Studies of Reading*, 21, 310–333. <https://doi.org/10.1080/10888438.2017.1291643>
- Kirby, J. R., Deacon, S. H., Bowers, P. N., Izenberg, L., Wade-Woolley, L., & Parrila, R. (2012). Children’s morphological awareness and reading ability. *Reading and Writing*, 25(2), 389-410.
- Kochhar, R., & Benenson, J. (2020). *The impact of COVID-19 on the U.S. labor market* [Report]. Pew Research Center. Retrieved from <https://www.pewresearch.org>.

- Kogan, V., & Lavertu, S. (2021). The Covid-19 pandemic and student achievement on Ohio's third-grade english language arts assessment. [https://glenn.osu.edu/sites/default/files/2021-09/ODE\\_ThirdgradeELA\\_KL\\_1-27-2021.pdf](https://glenn.osu.edu/sites/default/files/2021-09/ODE_ThirdgradeELA_KL_1-27-2021.pdf)
- Kreft, I., & de Leeuw, J. (1998). *Introducing multilevel modeling*. Sage Publications, Inc. <https://doi.org/10.4135/9781849209366>
- Kuhfeld, M. (2019). Surprising new evidence on summer learning loss. *Phi Delta Kappan*, 101(1), 25–29. <https://doi.org/10.1177/0031721719871560>
- Kuhfeld, M., Soland, J., Tarasawa, B., Johnson, A., Ruzek, E., & Liu, J. (2020). Projecting the potential impact of COVID-19 school closures on academic achievement. *Educational Researcher*, 49(8), 549–565. <https://doi.org/10.3102/0013189x20965918>
- Kuhfeld, M., Tarasawa, B., Johnson, A., Ruzek, E., & Lewis, K. (2020, November). Learning during COVID-19: Initial findings on students' reading and math achievement and growth NWEA Research. [https://www.ewa.org/sites/main/files/file-attachments/learning\\_during\\_covid-19\\_brief\\_nwea\\_nov2020\\_final.pdf?1606835922](https://www.ewa.org/sites/main/files/file-attachments/learning_during_covid-19_brief_nwea_nov2020_final.pdf?1606835922)
- Kuhn, M. R., & Stahl, S. A. (2003). Fluency: A review of developmental and remedial practices. *Journal of Educational Psychology*, 95(1), 3.
- Leach, J. M., Scarborough, H. S., & Rescorla, L. (2003). Late-emerging reading disabilities. *Journal of Educational Psychology*, 95(2), 211–224. <https://doi.org/10.1037/0022-0663.95.2.211>
- Lerkkanen, M., Pakarinen, E., Salminen, J., & Torppa, M. (n.d.). Reading and math skills development among Finnish primary school children before and after COVID-19 school closure. *Reading and Writing*, 36(2), 263–288. <https://doi.org/10.1007/s11145-022-10358-3>
- Lonigan, C. J., Schatschneider, C., & Westberg, L. (2008). Identification of children's skills and abilities linked to later outcomes in reading, writing, and spelling. Report of the National Early Literacy Panel. Washington, DC: National Institute for Literacy.
- Lovett, M. W., Frijters, J. C., Wolf, M., Steinbach, K. A., Sevcik, R. A., & Morris, R. D. (2017). Early intervention for children at risk for reading disabilities: The impact of grade at intervention and

- individual differences on intervention outcomes. *Journal of Educational Psychology*, 109(7), 889–914. <https://doi.org/10.1037/edu0000181>
- Lyon, G. R. (2001). Measuring success: Using assessments and accountability to raise student achievement. In Hearing before the subcommittee on education reform, committee on education and the workforce, U.S. House of Representatives, March 8, 2001.
- Maas, S. (2023). Assessing pandemic learning losses and recoveries. *National Bureau of Economic Research Digest*.
- Maldonado, J. E., & De Witte, K. (2021). The effect of school closures on standardised student test outcomes. *British Educational Research Journal*. <https://doi.org/10.1002/berj.3754>
- Marsh G., Friedman M., Welch V., Desberg P. (1981). A cognitive-developmental approach to reading acquisition. In Waller T.G., MacKinnon G.E. (Eds.), *Reading research: Advances in theory and practice* (Vol. 3, pp. 199-221). New York: Academic Press.
- Masten, A. S. (2018). Resilience Theory and Research on Children and Families: Past, Present, and Promise. *Journal of Family Theory & Review*, 10(1), 12–31.
- Maurer, U., Brem, S., Kranz, F., Bücher, K., Benz, R., Halder, P., Steinhausen, H., & Brandeis, D. (2006). Coarse neural tuning for print peaks when children learn to read. *Neuro Image*, 33(2), 749–758. <https://doi.org/10.1016/j.neuroimage.2006.06.025>
- Mayer, R. E. (2012). Information processing. In K.R.Harris, S. Graham, & T. Urdan (Eds.), *APA educational psychology handbook Vol. 1: Theories, constructs, and critical issues* (pp. 85-99). Washington DC: American Psychological Association.
- McDonald Connor, C., & McCardle, P. (2015). *Advances in reading intervention: Research to practice to research (Extraordinary Brain)* (1st ed.). Brookes Publishing.
- McGurk, H., & Macdonald, J. B. (n.d.). Hearing lips and seeing voices. *Nature*, 264(5588), 746–748. <https://doi.org/10.1038/264746a0>
- McKenna, M. and Stahl, K (2009). *Assessment of reading instruction*. New York NY: Guilford Press, p.23.
- Mesmer, H. A. E., & Griffith, P. L. (2005). Everybody’s selling it—but just what is explicit, systematic phonics instruction? *The Reading Teacher*, 59(4), 366– 376. <https://doi.org/10.1598/RT.59.4.6>

- Meyers, K., & Thomasson, M. A. (2020). Can pandemics affect educational attainment? Evidence from the polio epidemic of 1916. *Clometrica*, *15*(2), 231–265. <https://doi.org/10.1007/s11698-020-00212-3>
- Moscoviz L, Evans DK (2022) Learning loss and student dropouts during the COVID-19 pandemic: a review of the evidence two years after schools shut down. In: CGD Working Paper 609. Center for Global Development: Washington, DC
- Mousinho, R., & Correa, J. (2010). interrelação entre Processamento fonológico e compreensão leitora do 2 ao 4 ano do ensino fundamental: um estudo longitudinal. *Revista Psicopedagogia*, *27*(82), 27-35.
- Mousty, P., & Kolinsky, R. (1998). Why and how phoneme awareness helps learning to read. *Reading and spelling: Development and disorders*, 127.
- Muthen, B. O. (1991). Multilevel factor analysis of class and student achievement components. *Journal of Educational Measurement*, *28*(4), 338–354. <https://doi.org/10.1111/j.1745-3984.1991.tb00363.x>
- Muthén , B. O. (1994). Multilevel covariance structure analysis. *Sociological Methods & Research*, *22*(3), 376–398. <https://doi.org/10.1177/0049124194022003006>
- Muthén, B., & Satorra, A. (1989). Multilevel aspects of varying parameters in structural models. In Bock, R.D. (1989). *Multilevel analysis of educational data*. Elsevier eBooks (pp. 87–99). <https://doi.org/10.1016/b978-0-12-108840-8.50009-3>
- Nadori, N. (2020). An ecological perspective on reading development: A theoretical framework to guide empirical research. *JELTL (Journal of English Language Teaching and Linguistics)*, *5*(2), 261. <https://doi.org/10.21462/jeltl.v5i2.397>
- Nagy, W., Berninger, V. W., & Abbott, R. D. (2006). Contributions of morphology beyond phonology to literacy outcomes of upper elementary and middle-school students. *Journal of Educational Psychology*, *98*(1), 134.
- National Association of School Psychologists. (2020a). The pandemic's impact on special education evaluations and SLD identification [handout]. Author. <https://www.nasponline.org/resources->

- and-publications/resources-and-podcasts/covid-19-resource-center/webinar-series/the-pandemics-impact-on-academic-instruction-and-student-progress
- National Association of School Psychologists. (2020b). Considerations for academic screening upon the return to school [handout]. Author. <https://www.nasponline.org/resources-and-publications/resources-and-podcasts/covid-19-resource-center/return-to-school/considerations-for-academic-screening-upon-the-return-to-school>
- National Center for Education Statistics. (2020). Students' internet access before and during the coronavirus pandemic by household socioeconomic status. U.S. Department of Education.
- National Center for Education Statistics, U.S. Department of Education (2022). 2022 NAEP Reading Assessment: Highlighted Results at grades 4 and 8 for the Nation, States, and Districts. NCES 2022126. <https://www.nationsreportcard.gov/highlights/reading/2022/>.
- National Reading Panel. (2000). Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction. Washington, DC: U.S. Department of Health and Human Services. <http://www.nationalreadingpanel.org>
- Navas, A. L. G. P., Pinto, J. C. B. R., & Dellisa, P. R. R. (2009). Avanços no conhecimento do processamento da fluência em leitura: da palavra ao texto. *Revista da Sociedade Brasileira de Fonoaudiologia*, 14, 553-559.
- OECD (2019), The Survey of Adult Skills : Reader's Companion, Third Edition, OECD Skills Studies, OECD Publishing, Paris, <https://doi.org/10.1787/f70238c7-en>.
- Pape, K., Bj.rngaard, J. H., Westin, S., Holmen, T. L., & Krokstad, S. (2011). Reading and writing difficulties in adolescence and later risk of welfare dependence. A ten year follow up, the HUNT Study, Norway. *BMC Public Health*, 11(1). <https://doi.org/10.1186/14712458-11-718>
- Parviainen, T., Helenius, P., Poskiparta, E., Niemi, P., & Salmelin, R. (2006). Cortical sequence of word perception in beginning readers. *The Journal of Neuroscience*, 26(22), 6052–6061. <https://doi.org/10.1523/jneurosci.0673-06.2006>
- Patrinos, H. A. (2022). Learning loss and learning recovery. *Decision*, 49(2), 183–188. <https://doi.org/10.1007/s40622-022-00317-w>

- Peelle, J. E., & Sommers, M. S. (2015). Prediction and constraint in audiovisual speech perception. *Cortex*, *68*, 169–181. <https://doi.org/10.1016/j.cortex.2015.03.006>
- Perfetti, C. A., & Hart, L. (2002). The lexical quality hypothesis. In Verhoeven, L., Elbro, C., & Reitsma, P. H. (2002). *Precursors of functional literacy. Studies in written language and literacy* (pp. 189–213). <https://doi.org/10.1075/swll.11>
- Perfetti, C., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading*, *18*, 22–37. doi:10.1080/10888438.2013.827687
- Peugh, J. L. (2010). A practical guide to multilevel modeling. *Journal of School Psychology*, *48*(1), 85–112. <https://doi.org/10.1016/j.jsp.2009.09.002>
- Psacharopoulos, G., Collis, V., Patrinos, H. A., & Vegas, E. (2021). The COVID-19 cost of school closures in earnings and income across the world. *Comparative Education Review*, 000. <https://doi.org/10.1086/713540>
- Rack, J., Hulme, C., Snowling, M. J., & Wightman, J. (1994). The role of phonology in young children learning to read words: The direct-mapping hypothesis. *Journal of Experimental Child Psychology*, *57*(1), 42–71. <https://doi.org/10.1006/jecp.1994.1003>
- Raudenbush, S. W., & Bryk, A. S. (2002). Hierarchical linear models: Applications and data analysis methods. Thousand Oaks, CA: Sage.
- Relyea, J. E., Rich, P., Kim, J. S., & Gilbert, J. B. (2022). The COVID-19 impact on reading achievement growth of grade 3–5 students in a U.S. urban school district: variation across student characteristics and instructional modalities. *Reading and Writing*, *36*(2), 317–346. <https://doi.org/10.1007/s11145-022-10387-y>
- Reschly, A. L. (2009). Reading and school completion: Critical connections and Matthew effects. *Reading & Writing Quarterly*, *26*(1), 67–90. <https://doi.org/10.1080/10573560903397023>
- Ritchey, K. D., Silverman, R. D., Schatschneider, C., & Speece, D. L. (2013). Prediction and stability of reading problems in middle childhood. *Journal of Learning Disabilities*, *48*(3), 298–309. <https://doi.org/10.1177/0022219413498116>

- Rothou, K. M., Padeliadu, S., & Sideridis, G. D. (2013). Predicting early reading in Greek: the contribution of phonological awareness and non-phonological language skills. *Procedia-Social and Behavioral Sciences, 93*, 1504-1509.
- Rucklidge, J. J., McLean, A. P., & Bateup, P. (2009). Criminal offending and learning disabilities in New Zealand youth. *Crime & Delinquency, 59*(8), 1263–1286.  
<https://doi.org/10.1177/0011128709336945>
- Ruppert, D., Wand, M. P., & Carroll, R. J. (2003). *Semiparametric regression*. Cambridge University Press.
- Sacerdote, B. (2012). When the saints go marching out: Long-term outcomes for student evacuees from Hurricanes Katrina and Rita. *American Economic Journal: Applied Economics, 4*(1), 109–135.  
<https://doi.org/10.1257/app.4.1.109>
- Sargiani, R. D. A., Ehri, L. C., & Maluf, M. R. (2018). Orthographic mapping instruction to facilitate reading and spelling in Brazilian emergent readers. *Applied Psycholinguistics, 39*(6), 1405–1437.  
<https://doi.org/10.1017/S0142716418000371>
- Sandberg Patton, K. L., & Reschly, A. L. (2013). Using curriculum-based measurement to examine summer learning loss. *Psychology in the Schools, 50*(7), 738–753.  
<https://doi.org/10.1002/pits.21704>
- Satorra, A., & Muthen, B. (1995). Complex sample data in structural equation modeling. *Sociological Methodology, 25*, 267. <https://doi.org/10.2307/271070>
- Scarborough, H.S. (2001). Connection early language and literacy to later reading (dis)abilities: Evidence, theory, and practice. In Neuman, S and Dickinson, D. (E.Ds.), *Handbook for researching early literacy* (p97-110) New York, NY. Guilford Press.
- Schneider, J., & McGrew, K. (2012) Institute for Applied Psychometrics (IAP), 12-02-12., The Cattell-Horn-Carroll (CHC) model of intelligence v2.2: A visual. <http://www.iapsych.com/chcv2.pdf>.
- Share, D. L. (1999). Phonological recoding and orthographic learning: A direct test of the self-teaching hypothesis. *Journal of Experimental Child Psychology, 72*(2), 95–129.  
<https://doi.org/10.1006/jecp.1998.2481>

- Share D.L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition*, 55, 151-218.
- Seamer, J. (2022). Reading success in the early primary years: A teacher's guide to implementing systematic instruction.
- Serhan, D. (2020). Transitioning from face-to-face to remote learning: Students' attitudes and perceptions of using Zoom during COVID-19 pandemic. *International Journal of Technology in Education and Science*, 4(4), 335-342.
- Shinwell, J., & Defeyter, M. A. (2017). Investigation of summer learning loss in the UK—Implications for holiday club provision. *Frontiers in Public Health*, 5. <https://doi.org/10.3389/fpubh.2017.00270>
- Singh, A., Romero, M., Muralidharan, K. (2022). COVID-19 learning loss and recovery: panel data evidence from India. National Bureau of Economic Research. <http://www.nber.org/papers/w30552>
- Smith, R., Snow, P., Serry, T., & Hammond, L. (2021). The role of background knowledge in reading comprehension: A critical review. *Reading Psychology*, 42(3), 214-240.
- Snow, C. E., Griffin, P. E., & Burns, M. (2005). Knowledge to support the teaching of reading: Preparing teachers for a changing world. Jossey-Bass.
- Snowling, M. J. (2000). *Dyslexia*. Wiley-Blackwell.
- Snowling, M. J., & Hulme, C. E. (2005). *The science of reading: A handbook*. Blackwell Publishing.
- Snowling, M. J., Hulme, C., & Nation, K. (2022). *The science of reading: A handbook* (Wiley Blackwell Handbooks of Developmental Psychology) (2nd ed.). Wiley-Blackwell.
- Stafura, J. Z., & Perfetti, C. A. (2014). Word-to-text integration: Message level and lexical level influences in ERPs. *Neuropsychologia*, 64, 41–53. <https://doi.org/10.1016/j.neuropsychologia.2014.09.012>
- Statistics Canada, Employment and Social Development Canada, and Council of Ministers of Education, (2013). Skills in Canada – First Results from the Programme for the International Assessment of Adult Competencies (PIAAC). <https://www150.statcan.gc.ca/n1/en/catalogue/89-555-X2013001>
- Stapleton, L. M., McNeish, D. M., & Yang, J. S. (2016). Multilevel and Single-Level Models for Measured and Latent Variables When Data Are Clustered. *Educational Psychologist*, 51(3–4), 317–330.

Stawski, R.S. (2013). Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling (2nd Edition). *Structural Equation Modeling: A Multidisciplinary Journal*, 20(3), 541-550.

<https://doi.org/10.1080/10705511.2013.797841>

Sugg, M. M., Runkle, J. D., Andersen, L., Weiser, J., & Michael, K. D. (2021). Crisis response among essential workers and their children during the COVID-19 pandemic. *Preventive Medicine*, 153, 106852.

Swank, L. K., & Catts, H. W. (1994). Phonological awareness and written word decoding. *Language, Speech & Hearing Services in Schools*, 25(1), 9–14. <https://doi.org/10.1044/0161-1461.2501.09>

The Psychological Corporation (2005). Test de rendement individuel de Wechsler Deuxieme Edition: Version pour francophones du Canada [Wechsler Individual Achievement Test-Second Edition-French Version]. Toronto, ON: Harcourt Canada.

Tomasik, M. J., Helbling, L. A., & Moser, U. (2020). Educational gains of in-person vs. distance learning in primary and secondary schools: A natural experiment during the COVID -19 pandemic school closures in Switzerland. *International Journal of Psychology*, 56(4), 566–576.

<https://doi.org/10.1002/ijop.12728>

Toney, S., Light, J., & Urbaczewski, A. (2021). Fighting Zoom fatigue: Keeping the zombies at bay. *Communications of the Association for Information Systems*, 48(1), 10. British Columbia Ministry of Education. (2021). COVID–19 student impact: February 2021.

<https://studentsucces.gov.bc.ca/reporting>

Torgesen, J. K., Myers, D., Schirm, A., Stuart, E., Vartivarian, S., Mansfield, W., Haan, C. (2006). National assessment of the Title I interim report to congress: Volume II: Closing the reading gap, first year findings from a randomized trial of four reading interventions for striving readers. Washington, DC: U.S. Department of Education, Institute of Education Sciences. Retrieved from

<http://www2.ed.gov/rschstat/eval/disadv/title1interimreport/vol2.pdf>

United States Department of Education, Institute of Education Sciences, National Center for Education Statistics,. (n.d.).NAEP long-term trend assessment results: Reading and mathematics. *The*

- Nation's Report Card*. Retrieved March 2, 2024, from <https://www.nationsreportcard.gov/highlights/ltt/2022/>
- Vaughn, S., Linan-Thompson, S., Mathes, P., & Francis, D. J. (2005). Teaching English reading to English language learners in the primary grades. *Journal of Educational Psychology*
- Vaughn, S., Wexler, J., Leroux, A., Roberts, G., Denton, C., Barth, A., & Fletcher, J. (2011). Effects of intensive reading intervention for eighth-grade students with persistently inadequate response to intervention. *Journal of Learning Disabilities, 45*(6), 515–525. <https://doi.org/10.1177/0022219411402692>
- Vaughn, S. (2018). Introduction to the special issue on the simple view of reading from Pre-K to grade 12. *Remedial and Special Education, 39*(5), 259. <https://doi.org/10.1177/0741932518772912>
- von Hippel, P. T., & Hamrock, C. (2019). Do test score gaps grow before, during, or between the school years? Measurement artifacts and what we can know in spite of them. *Sociological Science, 6*, 43–80. <https://doi.org/10.15195/v6.a3>
- Wagner, R., Torgesen, J., & Rashotte, C. (2013). *Comprehensive Test of Phonological Processing - Second Addition*. Austin, TX: PRO-ED, Inc.
- Wanzek, J., & Vaughn, S. (2007). Research-based implications from extensive early reading interventions. *School Psychology Review, 36*, 541–561.
- Wechsler, D. (2015). *Wechsler Intelligence Scale for Children – Fifth Edition*. San Antonio, TX: The Psychological Corporation.
- Wong, J. (2022, June 6). How's your province or territory helping students recover from pandemic schooling? Here's what they told us. *CBC News*. <https://www.cbc.ca/news/canada/learning-curve-catch-up-recovery-plans-1.6472721>
- World Bank. (2022). *Covid-19 student learning loss: A short-term analysis*. World Bank Report.
- World Literacy Foundation. (2018). *The Economic & Social Costs of Illiteracy*. Retrieved from [TheEconomicSocialCostofIlliteracy-2.pdf](#)
- Zierer, K. (2021). Effects of pandemic-related school closures on pupils' performance and learning in select countries: A rapid review. *Education sciences, 11*, 252.



## Appendix A

## Supplemental Tables

Table 11

*Phonological Awareness & Word Reading Spline Model by Risk*

Predictors	Estimates	CI	p
(Intercept)	508.00	501.23 – 514.77	<0.001
TIS1m	2.10	1.47 – 2.73	<0.001
TIS2m	1.23	0.06 – 2.39	0.042
PA WR c	1.07	0.27 – 1.87	0.010
Risk WR1	-50.33	-58.85 – -41.81	<0.001
TIS1m × PA WR c	-0.01	-0.09 – 0.06	0.714
TIS2m × PA WR c	0.09	-0.05 – 0.23	0.217
TIS1m × Risk WR1	2.32	1.53 – 3.11	<0.001
TIS2m × Risk WR1	2.33	0.83 – 3.83	0.003
PA WR c × Risk WR1	2.71	1.44 – 3.98	<0.001
(TIS1m × PA WR c) × Risk WR1	0.07	-0.05 – 0.19	0.251
(TIS2m × PA WR c) × Risk WR1	-0.24	-0.48 – 0.00	0.054
<b>Random Effects</b>			
$\sigma^2$	108.90		
$\tau_{00 \text{ ID}}$	528.10		
$\tau_{11 \text{ ID.TIS1m}}$	1.80		
$\rho_{01 \text{ ID}}$	0.10		
ICC	0.84		
$N_{\text{ID}}$	214		
Observations	576		
Marginal R <sup>2</sup> / Conditional R <sup>2</sup>	0.675 / 0.946		

Note: TISm = Time in study in months, TIS1 = the school year, TIS2 = the summer. PA = Phonological Awareness, WR = Word Reading

**Table 12***Phonological Awareness & Decoding Spline Model by Risk*

Predictors	Estimates	CI	p
(Intercept)	501.09	496.26 – 505.92	<b>&lt;0.001</b>
TIS1m	1.31	0.74 – 1.89	<b>&lt;0.001</b>
TIS2m	1.55	0.29 – 2.82	<b>0.018</b>
PA DEC c	0.87	0.30 – 1.45	<b>0.003</b>
Risk DEC1	-21.54	-27.10 – -15.98	<b>&lt;0.001</b>
TIS1m × PA DEC c	-0.03	-0.10 – 0.04	0.354
TIS2m × PA DEC c	0.01	-0.14 – 0.16	0.906
TIS1m × Risk DEC1	0.88	0.23 – 1.54	<b>0.009</b>
TIS2m × Risk DEC1	-0.84	-2.30 – 0.63	0.269
PA DEC c × Risk DEC1	1.08	0.31 – 1.85	<b>0.007</b>
(TIS1m × PA DEC c) × Risk DEC1	0.09	-0.01 – 0.18	0.068
(TIS2m × PA DEC c) × Risk DEC1	-0.05	-0.26 – 0.16	0.668
<b>Random Effects</b>			
$\sigma^2$	94.36		
$\tau_{00 \text{ ID}}$	126.35		
$\tau_{11 \text{ ID.TIS2m}}$	0.00		
$\rho_{01 \text{ ID}}$	0.00		
ICC	0.57		
$N_{\text{ID}}$	214		
Observations	574		
Marginal R <sup>2</sup> / Conditional R <sup>2</sup>	0.623 / 0.839		

*Note:* TISm = Time in study in months, TIS1 = the school year, TIS2 = the summer. PA = Phonological Awareness, DEC = Decoding

**Table 13***Phonological Awareness & Decoding Fluency Spline Model by Risk*

Predictors	Estimates	CI	p
(Intercept)	514.90	509.48 – 520.31	<b>&lt;0.001</b>
TIS1m	2.06	1.46 – 2.67	<b>&lt;0.001</b>
TIS2m	-0.08	-1.45 – 1.28	0.906
PA DECF c	0.47	-0.14 – 1.07	0.133
Risk DECF1	-31.58	-37.80 – -25.35	<b>&lt;0.001</b>
TIS1m × PA DECF c	-0.03	-0.09 – 0.04	0.423
TIS2m × PA DECF c	0.01	-0.14 – 0.16	0.901
TIS1m × Risk DECF1	1.24	0.54 – 1.93	<b>0.001</b>
PA DECF c × Risk DECF1	1.14	0.28 – 2.00	<b>0.010</b>
TIS2m × Risk DECF1	-0.90	-2.48 – 0.68	0.269
(TIS1m × PA DECF c) × Risk DECF1	-0.02	-0.12 – 0.08	0.656
(TIS2m × PA DECF c) × Risk DECF1	0.06	-0.16 – 0.28	0.581
<b>Random Effects</b>			
$\sigma^2$	98.55		
$\tau_{00 \text{ ID}}$	167.68		
$N_{\text{ID}}$	212		
Observations	552		
Marginal $R^2$ / Conditional $R^2$	0.841 / NA		

*Note:* TISm = Time in study in months, TIS1 = the school year, TIS2 = the summer. PA = Phonological Awareness, DECF= Decoding Fluency

**Table 14***Vocabulary & Decoding Spline Model by Risk*

Predictors	Estimates	CI	p
(Intercept)	505.37	501.27 – 509.47	<0.001
TIS1m	1.17	0.73 – 1.61	<0.001
TIS2m	1.78	0.80 – 2.76	<0.001
Vocab DEC c	0.44	-0.30 – 1.18	0.247
Risk DEC1	-25.60	-30.69 – -20.50	<0.001
TIS1m × Vocab DEC c	-0.02	-0.10 – 0.06	0.563
TIS2m × Vocab DEC c	-0.06	-0.24 – 0.12	0.500
TIS1m × Risk DEC1	1.02	0.47 – 1.57	<0.001
Vocab DEC c × Risk DEC1	0.48	-0.44 – 1.40	0.302
TIS2m × Risk DEC1	-1.02	-2.26 – 0.22	0.107
(TIS1m × Vocab DEC c) × Risk DEC1	0.01	-0.09 – 0.11	0.796
(TIS2m × Vocab DEC c) × Risk DEC1	0.00	-0.22 – 0.22	0.976
<b>Random Effects</b>			
$\sigma^2$	97.39		
$\tau_{00 \text{ ID}}$	176.28		
$\tau_{11 \text{ ID.TIS2m}}$	0.00		
$\rho_{01 \text{ ID}}$	0.00		
ICC	0.64		
$N_{\text{ID}}$	214		
Observations	574		
Marginal $R^2$ / Conditional $R^2$	0.540 / 0.836		

*Note:* TISm = Time in study in months, TIS1 = the school year, TIS2 = the summer, Vocab = Vocabulary, DEC = Decoding

**Table 15***Vocabulary & Word Reading Fluency Spline Model by Risk*

Predictors	Estimates	CI	p
(Intercept)	516.77	511.05 – 522.50	<0.001
TIS1m	2.24	1.68 – 2.79	<0.001
TIS2m	-1.46	-2.60 – -0.33	0.012
Vocab WRF c	0.49	-0.36 – 1.35	0.262
Risk WRF1	-33.54	-40.35 – -26.72	<0.001
TIS1m × Vocab WRF c	-0.00	-0.08 – 0.08	0.993
TIS2m × Vocab WRF c	0.04	-0.12 – 0.21	0.601
TIS1m × Risk WRF1	1.09	0.43 – 1.75	0.001
Vocab WRF c × Risk WRF1	0.52	-0.62 – 1.66	0.377
TIS2m × Risk WRF1	0.77	-0.60 – 2.13	0.274
(TIS1m × Vocab WRF c) × Risk WRF1	0.02	-0.09 – 0.13	0.754
(TIS2m × Vocab WRF c) × Risk WRF1	-0.05	-0.27 – 0.18	0.671
<b>Random Effects</b>			
$\sigma^2$	92.71		
$\tau_{00 \text{ ID}}$	314.28		
$\tau_{11 \text{ ID}, \text{TIS1m}}$	0.59		
$\rho_{01 \text{ ID}}$	0.51		
ICC	0.75		
$N_{\text{ID}}$	214		
Observations	561		
Marginal R <sup>2</sup> / Conditional R <sup>2</sup>	0.563 / 0.892		

*Note:* TISm = Time in study in months, TIS1 = the school year, TIS2 = the summer, Vocab = Vocabulary, WR = Word Reading

**Table 16***Vocabulary & Decoding Fluency Spline Model by Risk*

Predictors	Estimates	CI	p
(Intercept)	517.73	513.05 – 522.42	<0.001
TIS1m	2.03	1.54 – 2.52	<0.001
TIS2m	0.32	-0.79 – 1.43	0.568
Vocab DECF c	0.09	-0.70 – 0.88	0.821
Risk DECF1	-34.15	-39.87 – -28.43	<0.001
TIS1m × Vocab DECF c	-0.05	-0.13 – 0.04	0.267
TIS2m × Vocab DECF c	-0.09	-0.28 – 0.09	0.326
TIS1m × Risk DECF1	1.23	0.62 – 1.83	<0.001
Vocab DECF c × Risk DECF1	0.86	-0.14 – 1.86	0.090
TIS2m × Risk DECF1	-1.17	-2.53 – 0.19	0.092
(TIS1m × Vocab DECF c) × Risk DECF1	0.05	-0.06 – 0.15	0.382
(TIS2m × Vocab DECF c) × Risk DECF1	0.08	-0.15 – 0.31	0.511
<b>Random Effects</b>			
$\sigma^2$	100.53		
$\tau_{00 ID}$	207.40		
$N_{ID}$	212		
Observations	552		
Marginal $R^2$ / Conditional $R^2$	0.831 / NA		

Note: TISm = Time in study in months, TIS1 = the school year, TIS2 = the summer, Vocab = Vocabulary, DECF = Decoding Fluency

Table 17  
Coupling Model for Phonological Awareness and Component Reading Skills

Predictors	Word Reading			Decoding			Word Reading Fluency			Decoding Fluency		
	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p
(Intercept)	479.56	473.49 – 485.63	<0.001	487.93	484.31 – 491.55	<0.001	493.50	488.93 – 498.08	<0.001	494.80	490.58 – 499.03	<0.001
TIS mon	2.98	2.66 – 3.30	<0.001	1.39	1.17 – 1.62	<0.001	1.59	1.32 – 1.86	<0.001	1.58	1.33 – 1.83	<0.001
PARS pmc	-0.26	-0.62 – 0.11	0.173	0.03	-0.26 – 0.32	0.834	0.17	-0.16 – 0.50	0.317	0.11	-0.20 – 0.42	0.474
Risk WR1	-50.11	-57.69 – -42.54	<0.001									
PA WR c	2.40	1.77 – 3.03	<0.001									
PARS pmc × Risk WR1	1.50	0.93 – 2.07	<0.001									
Risk DEC1				-23.05	-27.11 – -18.99	<0.001						
PA DEC c				1.38	1.03 – 1.73	<0.001						
PARS pmc × Risk DEC1				0.73	0.33 – 1.13	<0.001						
Risk WRF1							-31.44	-36.67 – -26.22	<0.001			
PA WRF c							1.20	0.76 – 1.64	<0.001			
PARS pmc × Risk WRF1							1.02	0.54 – 1.50	<0.001			
Risk DECF1										-32.41	-37.12 – -27.71	<0.001
PA DECF c										1.26	0.85 – 1.67	<0.001
PARS pmc × Risk DECF1										1.10	0.67 – 1.53	<0.001
<b>Random Effects</b>												
$\sigma^2$		176.50			96.10			130.42			106.60	
$\tau_{00}$		537.80 <sub>ID</sub>			129.61 <sub>ID</sub>			227.12 <sub>ID</sub>			173.13 <sub>ID</sub>	
$\tau_{11}$		0.00 <sub>ID.PARS_pmc</sub>						0.00 <sub>ID.PARS_pmc</sub>			0.00 <sub>ID.PARS_pmc</sub>	
$\rho_{01}$		0.00 <sub>ID</sub>						0.00 <sub>ID</sub>			0.00 <sub>ID</sub>	
ICC		0.75						0.64			0.62	
N		213 <sub>ID</sub>			213 <sub>ID</sub>			213 <sub>ID</sub>			211 <sub>ID</sub>	
Observations		570			568			555			547	
Marginal R <sup>2</sup> / Conditional R <sup>2</sup>		0.652 / 0.914			0.791 / NA			0.584 / 0.848			0.647 / 0.865	