The Efficacy of a Synchronous Online Reading Fluency Intervention with Struggling Readers

by

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We acknowledge with respect the Lekwungen peoples on whose traditional territory the university stands and the Songhees, Esquimalt and W̱SÁNEĆ peoples whose historical relationships with the land continue to this day.

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Abstract

The efficacy of reading interventions on elementary students' decoding and word reading skills and reading comprehension has been well-established in the literature. The efficacy of online reading interventions, however, is unknown. This study adapted an in-person reading fluency intervention for synchronous online implementation and examined its effectiveness in a single-case research design. Three struggling readers in grades 2 and 3 participated in an 8-week online reading intervention. Pre-test, post-test, and progress monitoring data were collected and analyzed. The results indicated that the online RAVE-O intervention was effective in increasing the participants' accurate word reading and decoding skills as well as their reading comprehension. The adapted intervention was implemented with fidelity and maintained its efficacy in an online setting. For struggling readers who cannot access intervention resources in person, an online reading intervention such as the one used in this study could have a positive effect on their reading skills.

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Dedication

This work is dedicated to my brother, Naud, and to all the other kids out there who find reading hard or stupid. I wish I could help you all and share my love for reading with you. I hope you will find many new worlds to explore and discover many stories that exhilarate you.

Introduction

In the first years of elementary school, students are faced with an important task: they need to learn to read. They need to master the manipulation of sounds and syllables in words, and achieve letter-sound correspondence knowledge. When students have mastered the alphabetic principle, that is, knowing that each letter in the alphabet corresponds with a specific sound(s) or phoneme(s), they start learning to recognize words that are often used in text. These most common words can quickly become sight words, words that do not need to be sounded out phonetically anymore, but are recognized and read in the blink of an eye (Ehri, 2005). From here, reading speed and reading accuracy will increase, facilitating reading comprehension with more exposure to text, and children will soon read to learn, from grade 3 and onward.

However, not every child will master these literacy skills at the same rate. Delays in the mastery of the alphabetic principle or phonological awareness (i.e., knowledge of the sound structures of spoken words) are early indicators of reading deficits and can lead to a host of academic disadvantages (Kilpatrick, 2015). The need for effective literacy and reading interventions has been well-documented (e.g., Scammacca et al., 2015; Wanzek et al., 2018), and there is a wealth of reading programs that aim to improve general reading skills or that specifically focus on developing phonological awareness or expand vocabulary skills, for example (e.g., Hodgins & Harrison, 2021; Morris et al., 2012).

Additionally, a recent development has affected young readers all over the world. With the outbreak of the global COVID-19 pandemic, schools had to quickly switch to online instruction and classes. In British Columbia (BC), the Minister of Education, Rob Fleming, announced an indefinite suspension of classroom instruction in K-12 schools on March 17, 2020 (Nair, 2020). As teachers set up online classrooms and provided remote instruction for their students, many parents and teachers alike began to wonder if students would fall behind in their

education due to the global pandemic and online schooling (Collie, 2020; Goldstein, 2020). The disruption of in-person education is expected to have serious consequences for many students, with learning gains in reading predicted to be two-thirds of what they would typically be after summer break (Kuhfeld et al., 2020). For students who were already performing below grade level, this disruption in their education and intervention programs has put them even further behind (O'Sullivan, 2020; Stein & Strauss, 2020).

The global pandemic necessitated an immediate need for efficient and effective online instruction models. While schools reopened again as the new academic year (20/21) began, the corona virus is far from eradicated, and the threat of a new surge in infections remains. With many students having returned to K-12 schools throughout BC, despite the many precautions that schools are taking, the possibility of another short- or long-term school closure is still present. Furthermore, many students that were already struggling in the classroom before the switch to online instruction might have fallen even further behind in the absence of intensive and individualized instruction during school closures (Kuhfeld et al., 2020). Effective online intervention programs that are supplemental to the classroom instruction could be the much-needed answer for these students, but research in synchronous online education and intervention is still in its early stages.

The present study aimed to redesign a reading intervention that has proven effective with in-person instruction for synchronous online instruction. The RAVE-O (Retrieval, Automaticity, Vocabulary Elaboration, Orthography) intervention (Wolf, 2011) is aimed at at-risk students who struggle with decoding and fluency skills. The program fosters deep reading processes through a focus on every aspect of a word (i.e., phonemes, meanings, morphemes, grammatical functions, and spelling patterns). So-called *core words* are introduced throughout the reading intervention, and the different meanings of these *core words* are explored. Students are asked to identify the

sounds and rime patterns in the *core words*, and practice writing the *core words*. Through repeated reading activities the students receive ample exposure to the *core words* and practice increasing their reading speed (Wolf, 2011). The comprehensive reading intervention has been shown to increase struggling readers' fluent reading skills after in-person instruction (e.g., Morris et al., 2012; Schmidt, 2019). The RAVE-O program was designed to be given in conjunction with a phonics intervention for one schoolyear (i.e., from October to March). The intervention consists of 70 1-hour sessions, with 30 minutes set aside for the phonics intervention and 30 minutes for the fluency intervention (Wolf, Miller, & Donnelly, 2000). Harrison and colleagues developed an abbreviated version of the RAVE-O intervention as a 15-session intervention (Harrison et al., 2017; Schmidt, 2019). The research presented here attempted to adapt the abbreviated RAVE-O intervention for synchronous online instruction while preserving the fidelity and effectiveness of this literacy intervention. This is not only important in case of another closure of K-12 schools due to COVID-19, but a good online reading intervention can also be immensely valuable to students who live in remote areas, in whose school district there may not be any or enough special education teachers. Students requiring Tier 2 or Tier 3 reading intervention in a Response to Intervention (RTI) model who may encounter accessibility issues (e.g., remote learners, lack of materials on-site, physical injuries, or mental illnesses) can benefit from an online intervention, if the fidelity and efficacy of the program when administered through synchronous online instruction can be maintained.

Review of the Literature

First, the different components of reading will be explored within the context of one of the most prevalent theoretical reading models, the Simple View of Reading (SVR). Then, the focus will shift toward the difficulties that beginning readers may encounter when learning to read, focusing specifically on naming speed difficulties that affect fluent reading and low vocabulary skills that influence comprehension of text. The principles of effective interventions will be discussed, as well as characteristics of reading interventions and online interventions. Lastly, the components of the RAVE-O intervention will be described and situated in the current models of reading.

Components of Reading

In order to be able to remediate difficulties in reading, it is first necessary to have an understanding of what reading is and what skills need to be developed and practiced to arrive at competent reading. Reading is the complex process of decoding the phonemes that are represented by letters (i.e., graphemes), identifying the word on the page, recalling the meaning of the word within the context from one's stored vocabulary, positioning the word in the larger sentence, and then constructing the meaning of the complete sentence. This sentence is usually part of a paragraph or larger piece of text. Inferences can be made from the sentence or the larger text, and the information from the text can be compared to prior knowledge and used to expand or modify the pre-existing knowledge that the reader has (Kirby & Savage, 2008; Tunmer & Chapman, 2012). The ultimate goal of teaching students to read is to ensure that they can construct meaning from, and interact with, text. Moreover, other subjects such as history, science, and even math are taught through textbooks that need to be read and understood. In order for children to learn critical academic and life skills, they first need to learn to read.

One theoretical model of reading succinctly summarizes this complex process in a simple view of reading. First introduced by Gough and Tunmer in 1986, the SVR states that reading comprehension is the product of decoding and linguistic comprehension and that both of these skills are necessary, but each skill alone is not sufficient for reading comprehension. In the SVR, decoding is defined as quick and accurate word recognition, facilitated by knowledge of the letter-sound correspondence rules (Gough & Tunmer, 1986). Linguistic comprehension is the "process by which, given lexical (i.e., word) information, sentences and discourses are interpreted" (Gough & Tunmer, 1986, p. 7). The SVR is a prominent theory in the field of reading research and has garnered a lot of support in the past 3 decades of research (e.g., García & Cain, 2014; Hoover & Gough, 1990). However, some researchers have questioned its simplicity and proposed additional components that are important for reading comprehension, such as fluency (e.g., Joshi & Aaron, 2000; Silverman et al., 2013; Tilstra et al., 2009) and vocabulary (e.g., Ouellette & Beers, 2010; Tilstra et al., 2009; Vellutino et al., 2007). Hoover and Tunmer (2018) emphasized that reading is complex, and that decoding, linguistic comprehension, and reading comprehension are not singular skills. Depending on how each original component of the SVR is defined, decoding can be understood to include fluency (i.e., quick and accurate word reading) and similarly, vocabulary can be seen as a subcomponent of comprehension. However, there is applied value in explicitly including fluency and vocabulary as additional components in reading models. These skills can be assessed and provide valuable information about individual students' reading skills, and this can lead to more targeted interventions based on children's individual reading profiles.

Decoding and Fluency: Similar or Separate Constructs?

Several studies have investigated the role of fluency in the SVR. Fluency is often defined as accurate and automatic decoding (Joshi & Aaron, 2000; Silverman et al., 2013; Tilstra et al.,

2009). The theoretical definition of decoding in the SVR includes automaticity as an important factor in word reading (Gough & Tunmer, 1986) but in many studies that investigated the SVR decoding has been operationalized as performance on pseudoword and word reading measures that only measure accuracy and not reading fluency (e.g., Tilstra et al., 2009; Tunmer & Chapman, 2012). Untimed measures of word and pseudoword reading are generally used to quantify the construct of decoding, disregarding the necessity of fluency in reading comprehension. However, for reading comprehension to occur, decoding must not only be accurate, but also fluent. For if word identification is laborious and slow, a student's working memory easily becomes overwhelmed. Students spend much of their cognitive capacity on decoding the word, matching phonemes to graphemes, and this leaves no room for retrieving the meaning of the word, and placing the word in the larger context of the sentence. If decoding is not fast, the reader might have forgotten the first words in the sentence by the time the last word in the sentence is read (Wolf & Katzir-Cohen, 2001).

Joshi and Aaron (2000) demonstrated the importance of fluency in the SVR in their study of the reading skills of 40 third-grade children. Tests of pseudoword reading, listening comprehension, and reading comprehension were administered, as well as a measure of processing speed. The participants were asked to name 40 letters of the alphabet that were printed on a page as quickly and accurately as they could. The results indicated that this measure of fluency explained an additional 10% of variance in reading comprehension, on top of the 48% of variance explained by decoding and listening comprehension (e.g., Joshi & Aaron, 2000). The researchers concluded that reading comprehension was better predicted when a measure of fluency was included in the model (Joshi & Aaron, 2000). Similar results were found across grades 4, 7, and 9 in a study of 271 struggling, average, and good readers (e.g., Tilstra et al., 2009). A measure of pseudoword reading was used for decoding, and fluency was measured with

a curriculum-based measure (CBM) of oral reading, which required participants to read three grade-level passages for one minute each. The average number of words read correctly in one minute was used as the participants' scores for fluency. Tilstra et al. (2009) found that in grade 4, fluency explained an additional 8% of the variance in reading comprehension, on top of decoding, listening comprehension, and vocabulary, for a total of 74% variance explained. Similar results for fluency were reported for the older students.

Silverman and colleagues (2013) added another perspective by researching whether fluency was a mediator or moderator of decoding in explaining reading comprehension. The researchers found that fluency and decoding were two separate but highly related constructs in their study of 284 fourth-graders. Surprisingly, when fluency was added to the model with decoding and linguistic comprehension to predict reading comprehension, Silverman et al. found that decoding was no longer a significant factor, and linguistic comprehension and fluency together explained 95% of the variance in reading comprehension. In this study, multiple measures were used for each variable. Measures of listening comprehension, vocabulary, and sentence-level semantic and syntactic skills were used to quantify the latent construct of linguistic comprehension, and the fluency construct included tests of sight word efficiency, passage reading fluency, and rapid automatized naming (RAN; the speed and accuracy with which letter-names are retrieved from memory, Silverman et al., 2013). The decoding construct was quantified by performance on tests of phonemic decoding, pseudoword decoding, and word identification. Decoding was conceptualized as merely accurate pseudoword and word reading, while fluency was defined as accurate *and* automatic word reading. This disparity in the operationalization of the latent constructs of decoding and fluency could explain why the fluency construct completely mediated the influence of decoding on reading comprehension. It emphasized the importance of automaticity as well as accuracy in word reading in grade 4 students (Silverman et al., 2013).

The role of fluency in earlier grades is unclear, as one study found decoding and fluency to be a single construct in second grade (e.g., Adlof, Catts, & Little, 2006). In their longitudinal study of 604 students, Adlof and colleagues (2006) investigated the role of fluency in predicting reading comprehension skill. Students were followed from second to eighth grade. In fourth and eighth grade, fluency and decoding represented different underlying skills, but Adlof et al. (2006) did not find a significant effect of fluency on reading comprehension. Two differences in the measures used could explain the discordant findings. Adlof et al. (2006) used both real and pseudoword accuracy and efficiency measures as well as a passage reading measure that was scored for both accuracy and rate. The accuracy score for each passage was included in the decoding construct, while the rate score for the same passages was included in the fluency construct. In addition, the inclusion of real word decoding and the inclusion of pseudoword fluency could have further increased the overlap between the two latent constructs, making them indistinguishable in second grade. Studies that did find a significant effect of fluency generally only included a pseudoword reading measure for decoding (e.g., Joshi & Aaron, 2000; Tilstra et al., 2009). Furthermore, a measure of processing speed was often included in the fluency construct (e.g., Joshi & Aaron, 2000; Silverman et al., 2013) whereas Adlof et al. (2006) did not measure processing speed.

The research summarised above shows that fluency is an important aspect of reading comprehension, explaining additional variance above and beyond decoding (when defined as accurate word reading) and linguistic comprehension. This highlights the potential efficacy of fluency interventions to increase reading comprehension in the early elementary grades and beyond (Tilstra et al., 2009). This is relevant to the study at hand, because one such fluency intervention, the RAVE-O intervention, has been found to increase reading skills in second and fourth grade students (e.g., Morris et al., 2012; Schmidt, 2019) and is hypothesized to have the

same effect when applied in a synchronous online environment. The RAVE-O program also focuses on the semantic aspects of words, or the multiple meanings that one word can have. The next section looks at the role of vocabulary knowledge in proficient reading skill.

The Role of Vocabulary in Reading

There has been much debate in the literature about the definition of linguistic comprehension in the SVR. Gough and Tunmer (1986) defined linguistic comprehension as the interpretation of spoken sentences based on one's vocabulary skills. A more expansive definition of linguistic comprehension was put forward by Kirby and Savage (2008), who stated that oral language comprehension consists of all verbal skills. This includes vocabulary knowledge as well as syntax, making inferences, and constructing mental schemas of the information conveyed. Both linguistic and reading comprehension are complex and encompass many component skills, some of which have not yet clearly been identified. One of the more widely studied components of reading comprehension, however, is vocabulary knowledge (Tunmer & Chapman, 2012). Interventions aimed at increasing reading comprehension have often included a vocabulary component, a comprehension strategies component, or both (Kilpatrick, 2015; Scammacca et al., 2015; Wanzek et al., 2016). The RAVE-O intervention also includes a vocabulary component, in which words are introduced with their multiple meanings. Through this activity, the students' vocabulary is expanded, which is hypothesized to have a positive effect on reading comprehension.

Several studies have demonstrated the importance of vocabulary to comprehension. In their study of 67 first grade and 56 sixth grade students, Ouellette and Beers (2010) administered measures of phonological awareness, decoding, irregular word recognition, vocabulary, and listening and reading comprehension. Their goal was to determine the amount of variance in reading comprehension that vocabulary knowledge explained over and above the decoding

measures and listening comprehension. In the younger participants, 71.2% of the variance in reading comprehension was explained by phonological awareness, decoding, and irregular word reading. Vocabulary did not contribute significantly to reading comprehension for these students (e.g., Ouellette & Beers, 2010). In grade 6, however, decoding was no longer a significant contributor, and vocabulary was the second largest contributor, explaining 15.3% of the variance in reading comprehension (e.g., Ouellette & Beers, 2010). The authors concluded that, as children age, vocabulary skills become more important and the relevance of decoding in explaining reading comprehension diminishes (Ouellette & Beers, 2010).

An experimental study by Tunmer and Chapman (2012) also sought to clarify the role of vocabulary in reading comprehension. A large sample (N = 122) of third graders completed several measures of letter-sound knowledge, context-free word recognition, vocabulary knowledge, and parallel forms of reading and listening comprehension tests (e.g., Tunmer & Chapman, 2012). As expected in the SVR, the measures that combined to form the construct of decoding strongly correlated with the measure of reading comprehension, while listening and reading comprehension were moderately correlated. Vocabulary also correlated significantly with all three components of the SVR, although more strongly with listening and reading comprehension than with decoding. Through an exploratory factor analysis, Tunmer and Chapman (2012) found that a two-factor solution was best, accounting for 89% of the variance in reading comprehension. The word recognition measures and the letter-sound knowledge test loaded onto the first factor, labeled Decoding, and vocabulary knowledge and listening comprehension loaded onto the second factor, Linguistic Comprehension. This result lent support to the notion that vocabulary should not be seen as a separate, additional component to the SVR, but instead as a skill included in the language comprehension component (Tunmer & Chapman, 2012). Furthermore, vocabulary was found to indirectly influence reading comprehension

through decoding, indicating that students with a larger vocabulary knowledge had an advantage when it came to decoding words. One hypothesis that could explain this finding is the *set for variability* theory (Venezky, 1999). This theory posits that when students generate a partial decoding of an unknown, irregular word, they can use this phonological representation and alter it until they have found a match to a word that they have stored in their vocabulary and that would semantically fit in the sentence. Thus, when students have a large vocabulary, they are more likely to arrive at a correct decoding and pronunciation of a new, irregular word, because the chances are higher that they have encountered the word before in spoken language (Tunmer & Chapman, 2012).

Vellutino et al. (2007) proposed a *Convergent Skills Model of Reading Development* that identified proximal and distal reading skills and cognitive abilities underlying the latent construct of reading comprehension. The researchers hypothesized that the two most independent latent constructs were phonological coding ability and visual coding ability. These two cognitive abilities influenced a variety of other skills, and all of these constructs were hypothesized to have a direct or indirect effect on context-free word identification (decoding in the SVR) and on language comprehension (linguistic comprehension in the SVR), which in turn interact and lead to reading comprehension (Vellutino et al., 2007). The researchers tested their model with two groups of participants, a group of younger students in grades 2 and 3 (n = 297) and a group of older students in grades 6 and 7 (n = 171). The students' language skills were assessed with a large battery of tests. Through confirmatory factor analyses, Vellutino and colleagues found support for the SVR: decoding strongly influenced reading comprehension in the younger group, but for the older group language comprehension skills correlated most strongly with reading comprehension. Furthermore, semantic knowledge had a strong, direct effect on language

comprehension, indicating that vocabulary skills, more so than syntactic knowledge, were important for language comprehension regardless of readers' age (e.g., Vellutino et al., 2007).

Tilstra et al. (2009) found that the importance of vocabulary increased as students became older. In their study of 271 students in grades 4, 7, and 9, the vocabulary measure explained 5% additional variance in reading comprehension on top of decoding and listening comprehension in fourth grade, and this increased to 12% in ninth grade (e.g., Tilstra et al., 2009). As children progressed through the grades, texts got increasingly more difficult and used a more expansive vocabulary. The role of decoding in predicting reading comprehension diminished as children became more proficient readers, and there was an increasing reliance on linguistic comprehension and vocabulary skills (Tilstra et al., 2009; Vellutino et al., 2007).

In conclusion, there is much evidence that supports the notion that reading comprehension is determined by the interaction between decoding skills and linguistic comprehension, which is the main notion of the SVR. However, several subcomponents to reading comprehension have been identified, most notably vocabulary (Ouellette & Beers, 2010; Tilstra et al., 2009; Tunmer & Chapman, 2012; Vellutino et al., 2007) and fluency (Adlof et al., 2006; Joshi & Aaron, 2000; Silverman et al., 2013). Due to its multiple components, and to increase reading comprehension in struggling readers, therefore, intervention programs targeting one or more subcomponents of reading comprehension and decoding are needed. Multicomponent interventions that incorporate activities that focus on several skills (e.g., decoding, vocabulary, fluency, and comprehension skills) are required for struggling readers as a supplement to their general classroom instruction (Wanzek et al., 2018). However, intervention programs should also be individualized and target specific student reading profiles (Wendling & Mather, 2009).

Reading Difficulties

In Canada, about 25% of third and fourth graders read below grade level (O'Sullivan, 2020). The difficulties these students experience when reading connected text can be caused by a variety of factors. As discussed above, reading is a complex process and relies on the optimal functioning of multiple processes and component skills that do not just influence the final product (reading comprehension) but that can also influence each other. If there is a deficit in one subcomponent, the student might be able to compensate adequately. Unfortunately, many students experience difficulties in multiple subcomponents of the reading process. From the SVR, three types of reading disabilities can be identified (Gough & Tunmer, 1986). First, struggling readers can have a deficit in decoding skills. This first type of reading disability is what is usually classified as dyslexia. Secondly, struggling readers can have a deficit in comprehension skills. This is also known as hyperlexia. Lastly, struggling readers can have a deficit in both decoding and comprehension skills. This was called a "garden variety reading disability" by Gough and Tunmer (1986, p. 7).

When struggling readers are classified based on their area(s) of weakness, intervention programs can be individualized to specifically target the skills that need to be improved. The efficacy of phonological intervention programs in increasing phonological awareness and decoding skills has been well-documented (Hodgins & Harrison, 2021; Rashotte et al., 2001; Morris et al., 2012; see also Wolf & Bowers, 2000). However, some students still struggle to develop fluent reading skills despite intensive intervention in phonological and decoding skills. These 'treatment resisters' are thought to have a double deficit in both phonological and naming speed skills (Wolf & Bowers, 2000). The *Double Deficit* hypothesis presents an alternative conceptualization of dyslexia, theorizing that there is not one single phonological core deficit but that there is a second core deficit of naming speed processes in dyslexia. Thus, the double deficit

hypothesis can be used to further classify students with dyslexia into three subtypes of struggling readers. First, readers with phonological deficits will struggle with phonological processing but not naming speed skills. The second type represents a single deficit in naming speed, with adequate phonological awareness or phonological decoding skills. Lastly, the third type is the double-deficit subtype, which includes readers with both phonological processing and naming speed deficits. These readers experience the most impairment and need intensive intervention in both phonological and naming speed skills (Wolf & Bowers, 2000).

Naming Speed Difficulties

A plethora of research found that many children and adults with reading disabilities show impaired or below-average performance on rapid naming tasks (Kirby et al., 2010; Wolf, Bowers & Biddle, 2000). In a single-deficit framework, researchers often classified naming speed (i.e., the ability to rapidly name familiar and simultaneously presented visual stimuli such as letters and numbers) as a subskill of phonological processes. However, Wolf, Bowers and Biddle (2000) argued that naming speed and phonological processes were two different, independent, processes. According to Wolf, Bowers and Biddle (2000), naming speed is a complex, multifaceted process. First, attentional processes need to be activated to perceive the stimulus (e.g., letter, number, colour, etc.). Visual processes then take place at multiple levels, at lower and higher spatial frequencies (Wolf, Bowers, & Biddle, 2000). Lower spatial frequencies attend to the global shape of the stimulus and operate faster than higher spatial frequencies, which register the details of the stimulus. The combined information from lower and higher spatial frequencies leads to recognition and identification of the stimulus, based on one's mental representations of the object (Wolf, Bowers, & Biddle, 2000). The quality of these mental representations affects the processing speed. Lexical processes that include the phonological and semantic subprocesses of access and retrieval then play a role in labeling the stimulus, and this collection of information is

passed on to motoric processes, which finally results in an articulated name for the stimulus (Wolf, Bowers, & Biddle, 2000). From the first perception of the stimulus to the eventual naming, this process generally takes less than 0.5 seconds. Because of the many components to naming speed processes, it is essential that all these processes are fast and work in concert with each other (Wolf, Bowers, & Biddle, 2000).

As described in the model of visual naming above (see Wolf, Bowers & Biddle, 2000), naming speed processes include phonological processes but are different in that attentional, linguistic and visual processes are also necessary to accomplish rapid naming. Instead, naming speed is thought to be more closely related to orthographic processing (Georgiou et al., 2009; Kirby et al., 2010). Orthographic processing is the ability to recognize frequently occurring groups of letters or words quickly and process them as a single unit instead of relying on letter-sound correspondence to identify and decode a word. In naming speed tasks that require students to name digits or colours, for example, it can be illustrated how it is conceptually more plausible that orthographic processing underlies naming speed more so than phonological processing. Digits and colours do not represent a specific phoneme like letters do, but instead have a name or label (e.g., 'seven' or 'green') that is stored as a singular unit in long-term memory (Kirby et al., 2010). Similarly, when students are asked to name letter-names (not letter-sounds) they have to rely on orthographic and lexical processes to retrieve the correct label for the stimulus (Kirby et al., 2010). The relationship between naming speed and reading can therefore be explained through orthographic processing. When words are recognized and processed as single units, the pronunciation of the word is the label for the orthographic unit of letters, and thus it is likely that the same underlying processes are utilized as for the retrieval of letter-names or digits in rapid naming tasks (Georgiou et al., 2009; Kirby et al., 2010).

A review of the research showed that naming speed strongly relates to word and text fluency, while phonological awareness relates to untimed measures of real and nonword decoding (Kirby et al., 2010; Wolf, Bowers, & Biddle, 2000). Naming speed can thus be used as one predictor of reading (dis)ability and is a crucial skill that can and should be targeted in an intervention if a student struggles with fluent reading. There have only been a few studies that examined whether naming speed could be improved through instruction, and those studies produced mixed results. Multicomponent interventions that included naming speed activities found that naming speed did not improve or improved only minimally, but the participants did show an increase in reading skills (e.g., Georgiou et al., 2009; Lovett et al., 2000). It could be that naming speed is a distal predictor of reading and a relatively stable trait that is minimally susceptible to intervention efforts. Naming speed is hypothesized to influence reading skill through other processes such as phonological or orthographic processing, which in turn affect reading fluency (Georgiou et al., 2009; Kirby et al., 2010). Thus, intervention efforts are best employed when targeting these more proximal predictors of fluency to increase reading proficiency (Kirby et al., 2010). Fluency is an important factor because if reading is slow and the reader uses most of their working memory on decoding the words on the page, there is less cognitive capacity available to spend on comprehending the text. Furthermore, reading will be slower and the first words in the sentence might have already been forgotten when the reader has reached the end of the sentence. If decoding is fluent, the reader can spend most of their cognitive capacity on understanding the text (Wolf & Katzir-Cohen, 2001). Additionally, an intervention aimed at reading fluency is important because if struggling readers can be taught to increase their reading speed, they will be able to read more connected text in a shorter period of time, thus increasing their exposure to text in a quantifiable way.

Low Vocabulary Skills

However, accurate and fluent decoding is not sufficient for reading comprehension, as outlined in the SVR. Linguistic comprehension is also necessary, as evidenced by hyperlexic students who can decode words accurately but who cannot explain the meaning of these words (Gough & Tunmer, 1986). Vocabulary, one part of linguistic comprehension, refers to the ability to define words and make connections between words (Tilstra et al., 2009). Researchers differentiate between the semantic lexicon and the phonological lexicon, with lexicon being the term used to describe the collection of words that is available in one's memory. The semantic lexicon then refers to the words for which the meaning is known, whereas the phonological lexicon also includes words that one has heard before, words that sound familiar but whose meaning is not known (Kilpatrick, 2015). This phonological lexicon is useful when a student is decoding a new, unfamiliar word. With regular words, sounding out each phoneme will likely lead to a correct pronunciation. However, English has many irregular words, words for which the spelling does not correspond to the pronunciation, and sounding those words out will not always lead to the right pronunciation (for example, *one*, *this*, and *enough*). If students have a large phonological lexicon, they can compare the partial decoding of the irregular word to words they have heard before, and the chance is high that a match can be found, which will help the student to arrive at the correct pronunciation of the irregular word. This process has been described in the *set for variability* hypothesis (Venezky, 1999). If the meaning of the word is then also found in the semantic lexicon, the student can apply that knowledge and arrive at a more complete understanding of the sentence or text. However, if a student's semantic and phonological lexicons are small, this can quickly lead to a lag in their reading development (Kilpatrick, 2015). A small lexicon or vocabulary can be due to a variety of causes. A lack of exposure to language as a toddler could be one explanation, or memory deficiencies could play a role. Poor comprehenders

need repeated exposures to words and their meaning to encode the novel vocabulary in their semantic lexicon (Cain et al., 2004). If a student's vocabulary is smaller than average, it can hinder the decoding of irregular words, it can restrict understanding of the text, and it can decrease the student's reading rate. Thus, vocabulary is an important component of reading, and if there is a deficiency in vocabulary skills, this can greatly affect reading comprehension.

In conclusion, students can experience reading difficulties for many different reasons due to the multiple component skills and processes underlying reading comprehension. The focus in the present study lies on fluency and vocabulary skills, which have been shown to be significant predictors of reading comprehension skill in elementary school students. At this stage in reading development, many students will have learned the alphabetic principle and phonic decoding. For below-average readers in early elementary grades, increasing fluency skills can be a viable route to proficient reading. While the effects of vocabulary on reading comprehension are typically greater in higher grades, a vocabulary component in a multicomponent intervention, such as the RAVE-O, can act as a preventative measure for later difficulties with vocabulary. Furthermore, through its indirect effect on decoding via set for variability and by integrating several aspects of word knowledge in an intervention, an increase in vocabulary can lead to an increase in reading proficiency. To effectively teach reading skills such as fluency and vocabulary, several general principles of effective instruction also need to be considered for an intervention to have the desired effect on student performance. These principles will be discussed in the next section.

Effective Academic Interventions

Deciding which students should receive intensive intervention is an everyday struggle for teachers and special educators, as there are often not enough resources to meet the unique needs of every child. The way in which eligibility for support services or special education is determined in schools has traditionally relied on an ability-achievement discrepancy model.

However, there are many disadvantages to this model, and therefore many school districts are switching to a response to intervention (RTI) model of service delivery and eligibility determination (McIntosh et al., 2011). Two important elements of RTI are (a) early intervention and (b) identification of students with learning disabilities (Fuchs & Fuchs, 2006). In an RTI model, all students receive evidence-based, high quality instruction that is focused on preventing learning delays or challenges (McIntosh et al., 2011). Schoolwide implementation of quality instruction maximizes learning for all students. The effectiveness of this instruction is assessed through schoolwide screening, usually at the beginning, in the middle, and at the end of the school year. Students that are not meeting the benchmark criteria for their grade are more closely monitored through monthly progress monitoring measures. Modifications to the instruction are made or early interventions are implemented for these students to close the gap with their peers. If the progress monitoring measures indicate that the student is not responding adequately to the intervention, the student can be referred for a psychoeducational assessment that can identify a learning disability, and more intensive intervention can be given to the student (McIntosh et al., 2011).

The RTI model provides students with high-quality instruction and support on a continuum, often divided into three tiers, although variations with more or less tiers exist (Fuchs & Fuchs, 2006; Kilpatrick, 2015; McIntosh et al., 2011). The first Tier is at the classroom level, where schoolwide quality instruction is given to all students in a whole group or small group delivery model. Tier 2 support refers to instruction or interventions that are supplemental to the classroom instruction and that are given to at-risk or struggling students to prevent or remediate learning difficulties. This additional instruction can be given in small groups and is usually more intensive than the classroom instruction. Struggling students who do not respond adequately to Tier 2 instruction can be moved into Tier 3, which provides even more intensive instruction,

usually in small groups or one on one (Kilpatrick, 2015; McIntosh et al., 2011). Students in Tier 3 typically may be diagnosed with a learning disorder, but this diagnosis is not required for students to receive Tier 3 intervention, since RTI is not primarily concerned with classification of learning disabilities, but more so with providing adequate instruction and support on a continuum to maximize the learning for all students (McIntosh et al., 2011).

Ongoing assessment and progress monitoring are important aspects of RTI which help instructors decide if a student should be moved up a tier or if the instruction has been effective. If the student is not responding to intervention, several adjustments can be made to make instruction more intensive. The supplemental instruction or intervention can be given more frequently, and session length can be increased as well. Group size can be reduced, so that the student(s) will have more opportunities to respond and receive constructive feedback (Fuchs & Fuchs, 2006). The Taxonomy of Intervention Intensity, described by Fuchs, Fuchs, and Malone (2017), includes seven principles that direct teachers and interventionists on how to intensify an academic intervention and monitor the student's response to intervention. These principles include: (1) The strength of the selected intervention program, (i.e., how effective it is for students with intensive intervention needs); (2) The dosage of the program, or how many opportunities the student gets to be actively engaged and give responses; (3) The alignment of the program, that is, how the program addresses the areas of need of the student and how it supplements typical classroom instruction; (4) Attention to transfer, which refers to how well the program addresses the transfer of targeted skills to other contexts and the connection between targeted skills and other related skills; (5) Comprehensiveness, or how well the intervention program incorporates the principles of effective instruction; (6) Behavioural support, to enhance self-regulation and executive functioning elements in the program as well as on-task behaviour; and (7) Individualization, which relates to how well the intervention program can be adapted to individual needs (Fuchs et

al., 2017). The authors described one way to individualize intervention in their article, which is data-based individualization (DBI). This method relies on the frequent collection of progress-monitoring measures throughout the intervention which provide the data needed to make decisions about how to adjust the program to meet the student's needs. In all, the taxonomy described above can be used to choose a suitable intervention program and then systematically adjust the program to create a good fit for the specific needs of the student (Fuchs et al., 2017).

The principles of effective instruction, mentioned in the fifth dimension (comprehensiveness), have been widely researched. Wendling and Mather (2009) compiled a list of the most important and effective teaching principles. These principles include (1) Actively engaging students in activities through explicit and direct instruction; (2) Giving students many opportunities to learn and respond with a built-in and high success rate through scaffolding instruction; (3) Addressing different forms of knowledge as well as providing strategies for organizing and activating this knowledge; and (4) Strategically teaching sameness, to augment transfer of skills and knowledge across different subject areas. To evaluate the quality of their instruction, teachers should evaluate the amount of time students are actively engaged in a task, they should look at the students' success rates, and ensure that students are progressing through the curriculum (Wendling & Mather, 2009).

Effective Reading Interventions

In reading interventions specifically, consensus in the research has indicated that instruction needs to be explicit and systematic. To make instruction explicit, the teacher or interventionist needs to give clear and precise instruction when teaching letter-sound correspondence. Furthermore, phonic blending and segmentation needs to be taught directly to students (Kilpatrick, 2015). Secondly, instruction in reading needs to be systematic. For example, in phonics instruction a specific sequence for teaching letter-sound relationships needs to be

planned and followed. Some letter-sounds are easier to learn than others, and so most students benefit from a systematic and explicit approach to teaching early literacy skills, such as phonics and decoding (Kilpatrick, 2015).

Components of Word-Level Interventions. In a review of the research, Kilpatrick (2015) identified the intervention studies that had the largest effect on word identification skills, as measured by norm-referenced tests, and found that all of these successful studies included a phonological awareness component, a phonics component, and the participants were provided with many opportunities to practice reading connected text.

One example of such an intervention was the Spell Read intervention, implemented in a small-group format with 115 struggling readers in grades 1 through 6 from one elementary school in Newfoundland, Canada (e.g., Rashotte et al., 2001). Participants were matched for grade and reading skill and then randomly assigned to the treatment group or the control group. In a multiple-baseline design, the treatment group first received the Spell Read intervention for eight weeks, after which all 115 students received the post-test measures. Then, the control group received the same intervention for seven weeks, and the study was concluded with a second post-test for all participants (e.g., Rashotte et al., 2001). This meant that the group who first received the Spell Read intervention was tested immediately after the end of the intervention and again after two months, during which they only received the regular classroom instruction. This research design allowed the researchers to examine whether the Spell Read intervention was effective, compared to regular classroom instruction, and whether the intervention had lasting effects on the phonological and word-level reading skills of the participants. Intervention sessions took place daily, in small groups of 3 to 5 students, for an average total of 35 hours of intervention for the first group and 31 hours of intervention for the second group (e.g., Rashotte et al., 2001). Each intervention session consisted of 30 minutes of phonemic activities, 15

minutes of oral reading, and 5 minutes of free writing, to promote students' reading comprehension. The results indicated that students across all grades improved on their phonological and fluent decoding skills, their accurate word and text reading, and their reading comprehension, but not their fluent word reading skill (e.g., Rashotte et al., 2001). These improvements were sustained two months after the intervention had been discontinued for the first intervention group, and further growth on the phonological and reading comprehension measures was found. The largest effect sizes were found on the pseudoword decoding measure and on the phonological awareness measures (e.g., Rashotte et al., 2001). The results from this study indicate that a small-group, 8-week intervention with a phonological component and a text-reading component can be effective in increasing elementary students' phonological and accurate word reading skills as well as their reading comprehension.

When considering word reading fluency, however, only modest gains were found in the study by Rashotte et al. (2001). One possible explanation points out the relation between fluency skills and sight-word acquisition (Rashotte et al., 2001). Readers that have a lot of sight-words can read connected text faster. Students with a small sight-word vocabulary have to spend more time on decoding unfamiliar words. And because it takes these students longer to read the same amount of text as typically developing peers, they read less and have less opportunities to expand their vocabulary. If the sight-word vocabulary of these struggling readers can be increased, an increase in word reading fluency will likely follow in time (Kilpatrick, 2015). However, Rashotte et al. (2001) concluded that an 8-week intervention was too short to lead to a significant growth in students' sight-word vocabularies, and thus word reading fluency was not improved. Hence, fluency and vocabulary are also important components to address in reading interventions.

Components of Comprehension Interventions. Vocabulary is a well-researched component in interventions addressing reading comprehension difficulties and its positive effect

has been established in many research studies (Scammacca et al., 2015). A distinction can be made between receptive vocabulary and expressive vocabulary: receptive vocabulary encompasses all the words that children can understand in hearing or reading; expressive vocabulary includes all the words that children can understand when using it to express themselves (Wendling & Mather, 2009). The goal of many vocabulary interventions is to increase a child's receptive and expressive vocabularies. This can be done by teaching vocabulary directly and indirectly. Furthermore, novel words need to be encountered more than once and in multiple contexts, so that rich connections to the word can be built (Wendling & Mather, 2009). Many words also have multiple meanings, but some meanings are only encountered in specific contexts. Therefore, explicit instruction is necessary to teach words in multiple contexts.

Another common component of reading comprehension interventions is strategy instruction. Reading comprehension can be improved by explicitly teaching comprehension strategies to students with poor comprehension. Some of the skills addressed by these comprehension strategies include inferencing, summarizing, and comprehension monitoring (Kilpatrick, 2015; Scammacca et al., 2015; Wanzek et al., 2016). Cooperative learning and answering and generating questions are also effective comprehension strategies. Furthermore, organizing or structuring the text can be very beneficial. Graphic and semantic organizers can be used, as well as story structures (Wendling & Mather, 2009).

Multicomponent Reading Interventions. Although all of the components described above have been effective in remediating reading difficulties, it is often not feasible to implement a separate intervention for each area of weakness of a student. Multicomponent interventions could be a time-efficient solution for teachers. An integrated, well-rounded reading intervention has a high likelihood of increasing reading skills, and through its effect on several subcomponents of reading comprehension, it can increase reading comprehension skills as well.

Wanzek and colleagues found no difference in effectiveness when comparing foundational skills interventions to multicomponent interventions in a meta-analysis of reading interventions implemented in kindergarten to grade 3 (e.g., Wanzek et al., 2016). In this meta-analysis, interventions that included a foundational skills component as well as a comprehension or language component were classified as multicomponent. Upon further inspection, Wanzek et al. (2016) found that these multicomponent studies generally included a comprehension component, and about half of the interventions also included a vocabulary component. Many of the multicomponent studies were implemented in kindergarten and grade 1, but not in grades 2 to 3 (e.g., Wanzek et al., 2016).

However, spending time on comprehension instruction in the earliest grades might not be the most efficient use of intervention time, as students' comprehension is limited by their decoding and oral language skills, which have not yet fully developed (Gough & Tunmer, 1986; Tunmer & Chapman, 2012; Wanzek et al. 2016). This limitation in basic skills could also explain the differential finding in a meta-analysis focused on older readers in grades 4 to 12 (e.g., Scammacca et al., 2015). These researchers found that comprehension interventions were more effective than multicomponent interventions. In this meta-analysis, multicomponent interventions typically included fluency and comprehension strategy components, as well as vocabulary instruction. Furthermore, vocabulary interventions led to higher effect sizes than all other types of interventions when a range of outcome measures, both standardized and non-standardized, were included. The findings from Scammacca et al. (2015) reiterate the importance of vocabulary instruction for advancing reading comprehension in older students. Another meta-analysis that evaluated the effectiveness of extensive reading interventions (at least 75 sessions) in grades 4 to 12 reported that a majority of the included studies implemented a multicomponent reading intervention (e.g., Wanzek et al., 2013). However, intervention type was not included in the

moderator analysis and therefore it was unclear whether the multicomponent interventions were more or less effective than single-component interventions.

Intensity of Reading Interventions. Although many people assume that longer interventions are more effective, results from several meta-analyses indicate that this is not the case. Wanzek and Vaughn (2007) synthesized the findings from 18 studies that implemented extensive reading interventions in grades K-3. The authors implemented the definition of "occurring for 100 sessions or longer, which is the equivalent of 20 weeks of daily intervention" (p. 542) for extensive interventions (Wanzek & Vaughn, 2007). These interventions could also be classified as Tier 3 interventions in an RTI model. Positive outcomes on reading measures were found. Wanzek and Vaughn's work was recently extended in a meta-analysis that reported a small positive effect size of extensive reading interventions on early reading skills (e.g., Wanzek et al., 2018). Extensive interventions were again implemented for at least 100 sessions in grades K-3. Many studies included in this meta-analysis reported that participants received intervention sessions daily, while the rest of the studies implemented intervention sessions four times per week. The duration in weeks of the implemented interventions varied widely across studies, ranging from 10 to 130 weeks. The median was 25 weeks. For the moderator analysis, a distinction was made between interventions that were implemented for 25-63 hours and interventions that lasted longer than 63 hours, but no differences in effect size were found between these two groups. Length of intervention was not a moderator (e.g., Wanzek et al., 2018).

Extensive interventions implemented for 75 sessions or more in grades 4 to 12 were also found to have a small effect on a variety of reading outcomes (e.g., Wanzek et al., 2013). No significant differences between studies were found with regard to hours of intervention in this meta-analysis, but another meta-analysis of reading interventions in grades 4 to 12 did find that

the length of the intervention functioned as a moderator (e.g., Scammacca et al., 2015). Studies with at least 26 hours of intervention were associated with smaller mean effect sizes than studies with less than 16 hours of intervention. This negative correlation could be due to other factors: Studies published between 2005 and 2011 generally included longer interventions (with at least 16 hours of intervention) than studies published before 2005, and the differences in effect sizes between those two groups of studies are more likely caused by an increased use of standardized measures and changes in the business-as-usual comparison conditions (Scammacca et al., 2015). Nevertheless, this finding indicates that interventions of shorter duration do not necessarily lead to reduced effectiveness when compared to interventions of longer duration. More specifically, a phonological awareness intervention that lasted 10 weeks was found to be effective in increasing kindergartners' phonological processing and fluency skills (e.g., Hodgins & Harrison, 2021). The 8-week Spell Read intervention was effective in increasing a range of literacy skills for struggling readers in grades 1 to 6 (e.g., Rashotte et al., 2001). Additionally, another meta-analysis that summarized the results of short(er) Tier 2 interventions among K-3 students found moderate effects on foundational reading skills and small effects on reading comprehension measures (e.g., Wanzek et al., 2016). Interventions were considered a Tier 2 intervention if 15-99 sessions were implemented. This was decided so that studies which were excluded from the Wanzek and Vaughn (2007) and Wanzek et al. (2018) syntheses were included in this meta-analysis. Once again, total hours of intervention was not a significant moderator (e.g., Wanzek et al., 2016). Despite the discrepancy in intervention length (less than 100 sessions or more than 100 sessions), both meta-analyses found small to moderate effect sizes. Although these effect sizes were not directly compared to each other, and thus it is unclear whether extensiveness of the intervention (15-99 versus 100+ sessions) would be a significant moderator, it appears that less extensive interventions can be just as effective as longer, more extensive interventions. One benefit of

shorter interventions is that they are easier to implement in a research study and are less likely to have high rates of attrition.

Reducing group size has traditionally been another way to intensify instruction. In an RTI model, students are moved from Tier 1 to Tier 2 services by taking them out of a full classroom to give the struggling students small-group or individual intervention (Fuchs & Fuchs, 2006; McIntosh et al., 2011). To further intensify instruction, teachers are advised to give students in Tier 3 one-on-one intervention, as this has been said to be most beneficial to the students and give them the most opportunities for learning (Fuchs & Fuchs, 2006). However, many of the meta-analyses discussed above also included group size in their moderator analyses and none found group size to explain significant differences in effect sizes between studies. Small group interventions (2-5 students) did not differ in effectiveness from one-on-one interventions (e.g., Wanzek et al., 2016; Wanzek et al., 2018) or from large group (5+ students) interventions (e.g., Wanzek et al., 2013).

In conclusion, reading interventions have been found to have a small to moderate positive effect on reading outcomes in early (e.g., Wanzek et al., 2016; Wanzek et al., 2018) and later grades (e.g., Scammacca et al., 2015; Wanzek et al., 2013). No significant differences of group size or total hours of intervention were found, although the results regarding intervention type were more varied. Some studies found that multicomponent interventions can be just as effective as single-skill interventions (e.g., Wanzek et al., 2016; Wanzek et al., 2018), whereas other results indicated that vocabulary and reading comprehension interventions were more effective than multicomponent interventions (e.g., Scammacca et al., 2015). Based on these findings, the present study utilized a small-group design (1:2) and implemented an 8-week online intervention that consisted of two 1-hour sessions per week for a total of 16 intervention sessions.

Online Interventions

A comprehensive database of reading intervention research has identified the most effective approaches to remediating reading skills. However, it is unclear how these approaches translate to online environments. Reading interventions have traditionally been implemented in-person with students and this is reflected in the research. There has been limited research on the effectiveness of online schooling, and even less so on interventions implemented online. The present study ventures into this unknown territory by adapting a reading intervention for synchronous online implementation. To do so effectively, it is important to know which teaching principles and which aspects of reading interventions are applicable to online intervention programs.

The sudden closure of schools in BC due to the COVID-19 pandemic presented diverse challenges for teachers and special educators. Schools and teachers across the nation differed in their approach to online education. Some teachers chose to send their students a package of worksheets and assignments at the beginning of each week and maintained communication through email. Other teachers continued to teach their students in real time through videoconferencing apps such as Zoom or Microsoft Teams. These two approaches reflect an important distinction, namely asynchronous versus synchronous online instruction. Asynchronous indicates that there is a delay in communication, and teacher and students are not online at the same time. Synchronous refers to communication that takes place in real time between two parties, who are both online at the same time (McCord et al., 2020). Another important term used in the present research is remote instruction, meaning that the teacher or interventionist is not at the same location as the student. Online instruction is not always remote instruction, because the teacher can be in the same room as the student to supervise the online activities of the student. In the context of the COVID-19 pandemic, however, the terms online

schooling, online classes, and online teaching do have the connotation of being remote, since schools were closed and teachers and students were in separate locations. Therefore, in this study, the terms online instruction and online intervention were used to indicate online remote instruction and/or intervention. Most of the existing research on online remote instruction relates to courses and interventions that have an asynchronous delivery method.

The research on the effectiveness of online schooling is divided. Some studies have found that students in face-to-face classes perform better on statewide achievement tests when compared to students enrolled in online classes that are taught asynchronously. Other online schools achieve excellent results with regard to student academic performance (Morgan, 2015). Online instruction can be beneficial for students with disabilities, because it allows for high levels of individualization and technological tools can easily be used during instruction by the student and by the teacher. Extended time and flexible location are two more benefits of online courses. However, drawbacks are that a high level of self-regulation on the part of the student is required, as well as good communication and time-management skills. Moreover, the amount of interaction between teacher and student(s) is substantially lower than in face-to-face contexts. This reduced personal interaction can be alienating for both students and teachers (Morgan, 2015). Furthermore, parental support is a key factor for student achievement, and this might be even more important in online schooling. Parents may need to take up more responsibilities, in the form of monitoring their child(ren)'s work and on-task behaviour, and provide technical support (e.g., Morgan, 2015; Fitzgerald et al., 2012).

An asynchronously implemented word identification intervention was found to be effective in increasing oral reading skills and reading comprehension in five students with a reading disability (e.g., Fitzgerald et al., 2012). One limitation of this study was that parental facilitation was not controlled or measured, and therefore it was not clear how much help the

students received from their parents that were present in the same room. The researchers used PowerPoint presentations combined with text-to-speech audio to deliver the intervention. Important instructional design variables included clear audio of the text on the PowerPoint slide, opportunities for active engagement through worksheets, and teacher modelling of the strategy steps (e.g., Fitzgerald et al., 2012). Several challenges for implementation were encountered. First, technology limitations needed to be taken into account, and technology skills necessary for the intervention needed to be explicitly taught to students and their parents. Furthermore, family schedules affected when intervention tasks were completed and limited student availability (Fitzgerald et al., 2012). Another large-scale online reading intervention was found to significantly increase the reading fluency and spelling skills of students in the treatment group, compared to a control group (e.g., Schneider et al., 2016). This intervention was implemented four days a week for 30 minutes in the school computer lab, but without any teacher support, neither in person nor online.

With regard to synchronous online intervention, a Tier 3 mathematics intervention with struggling middle school students was found to significantly increase tutored students' mathematics assessment scores (e.g., Chappell et al., 2015). Through synchronous online tutoring, an intensive, individualized intervention was implemented. The intervention took place twice a week for 30-40 minutes per session and lasted for 20 weeks. Students did not always receive intervention from the same tutor; instead, students worked with six to eight different tutors on average. Instruction was given one-on-one and used synchronous instant messaging and virtual whiteboard technology, but no videoconferencing. Throughout the intervention, progress monitoring measures advised tutors and allowed for individualized differentiation of instruction when necessary. Furthermore, tutors provided guided practice and scaffolding to the students and

gave multiple explanations when difficult concepts were encountered. The online intervention was also evaluated positively by the participating students (Chappell et al., 2015).

To summarize, effective online interventions use many of the same principles for effective instruction as face to face instruction, such as teacher modelling, guided practice, scaffolding, and active engagement (e.g., Chappell et al., 2015; Fitzgerald et al., 2012; Wendling & Mather, 2009). Most importantly, progress monitoring was continuously used in a Tier 3 online math intervention to inform instruction for individual students in each session (Chappell et al., 2015). However, challenges to online implementation were also reported, most notably with regard to technology skills and family interference (Fitzgerald et al., 2012). No research on a synchronous online implemented reading intervention could be found, most likely because such interventions are typically delivered in-person in schools or clinical settings. The present study aims to address this gap in knowledge by examining the efficacy of a synchronous online reading intervention.

DiPietro et al. (2008, as cited in Morgan, 2015) reported that effective teachers in virtual schools were proficient in using several different types of technology and implemented new technologies to enhance virtual learning environments. They ensured student motivation was high and included topics in their lessons that students were interested in. Communication was a key factor, and effective teachers encouraged students to communicate with peers and with the teacher in many ways. Moreover, feedback was provided to students in a timely manner. Likewise, assessment and progress monitoring was essential (Chappell et al., 2015; McCord et al., 2020). Research in the field of telepsychology indicates that diagnosis and assessment can effectively be achieved through the use of telecommunication tools such as videoconferencing. Psychotherapy sessions delivered through videoconferencing have been associated with similar outcomes as in-person care and have good user satisfaction. Furthermore, telepsychology has

higher rates of accessibility and is cost-effective (McCord et al., 2020). If implemented well, educational interventions are hypothesized to have similar results.

In conclusion, principles for effective instruction and intensification of intervention programs seem to be applicable to online interventions as well. The main pillar for effective instruction in reading is that it needs to be taught explicitly and systematically. Furthermore, the students need to be actively engaged and provided with ample opportunities to respond and receive feedback. Teachers should model strategy use and give multiple explanations. Feedback needs to be constructive and there should be enough chances for the students to experience success. The transfer of newly learned skills also needs to be addressed in effective instruction and intervention programs, as many skills can be used in different contexts (Fuchs et al., 2017; Wendling & Mather, 2009). Effective reading interventions are not constricted by length of intervention and group size (Scammacca et al., 2015; Wanzek et al., 2013; 2016; 2018). Synchronous online intervention can provide cost-effective and accessible services to a wide variety of students, including students in isolated or rural areas and students that cannot attend school in-person because of health concerns or other disabilities (Chappell et al., 2015; Fitzgerald et al., 2012; McCord et al., 2020). Limited research on the efficacy of online interventions has been conducted. The implementation of a synchronous online reading intervention for elementary students with reading deficits in this study is a first attempt at assessing the effectiveness and practicality of a synchronous online reading intervention. The reading intervention that was selected and adapted for online use was the RAVE-O Proven Literacy Intervention (Wolf, 2011).

The RAVE-O Fluency Intervention

The RAVE-O program is a fluency intervention for students in grades 2 to 5 and is specifically designed to target phonemic awareness deficits, fluency deficits, and rapid naming deficits (Wolf, 2011). It is based on an integrative model of reading that includes phonological,

orthographic, and semantic knowledge (Wolf, Miller, & Donnelly, 2000). Proficient reading relies on decoding skills, orthographic mapping, and knowledge of the meaning of words, among other skills. Through explicit teaching and engaging activities, the RAVE-O targets these components of reading. The RAVE-O intervention also includes activities that increase fluency in word- and text-level reading outcomes. When words are firmly encoded in long-term memory and surrounded with many associations (i.e., meanings, morphemic variations, rime families), they can be retrieved faster, and thus reading fluency is increased (Wolf, 2011). The goal of the RAVE-O program is "to help children activate phonological, orthographic, and semantic information about words more automatically and to facilitate fluency in word recognition and comprehension" (Wolf, Miller, & Donnelly, 2000, p. 384).

The RAVE-O intervention consists of 70 sessions, divided into one introductory unit and 15 instructional units (Wolf, 2011). The program was adapted for use in research and abbreviated to 15 sessions, one for each instructional unit (Harrison et al., 2017; Schmidt, 2019). Lessons were condensed and review sessions dropped. Additionally, several activities, such as the writing tasks, were excluded so that each of the 15 sessions lasted 45 minutes. The abbreviated RAVE-O intervention aims to increase fluency and word reading skills. It can be implemented as a Tier 3 intervention in small groups or one-on-one (Harrison et al., 2017).

The RAVE-O intervention, with its emphasis on fluency and automaticity in (sub-)lexical skills, corresponds to the double deficit hypothesis and is hypothesized to mitigate naming speed deficits that students with a double deficit in phonological and naming speed skills experience through orthographic processing activities (Wolf, Miller, & Donnelly, 2000). Furthermore, fluency has been shown to be a crucial part of decoding processes, which in turn predict reading comprehension skills. Additionally, the attention to semantic and lexical retrieval skills in the RAVE-O program can build vocabulary skills. Through decoding and vocabulary, the RAVE-O

intervention can increase reading comprehension in elementary school students with reading deficiencies, specifically those students with decoding accuracy and fluency difficulties (Wolf, 2011).

Efficacy of the RAVE-O program

The RAVE-O intervention was compared to another multi-component intervention in a large-scale evaluation by Morris et al. (2012). To test the effectiveness of the reading interventions, the researchers recruited students in grades 2 and 3 with reading difficulties, and assigned the participants to one of four test conditions. In the first condition, students received the Phonological Analysis and Blending/Direct Instruction (PHAB) intervention, plus the fluency-focused RAVE-O intervention. In the second condition, students received the PHAB plus the Word Identification Strategy Training (WIST) component, an intervention aimed at teaching word identification strategies. The third condition was a phonological control condition where students received the PHAB paired with a classroom survival skills (CSS) program. The last condition included alternate, non-reading interventions, namely the CSS program combined with a mathematics program component (MATH). Through this design, three orthogonal contrasts could be compared. The first contrast compared the CSS+MATH control condition to the three conditions that included the PHAB reading intervention. The second contrast looked at the increased effectiveness of the multicomponent interventions over the phonological-only (PHAB+CSS) condition. The third and last contrast compared the two multicomponent interventions to each other (PHAB+WIST vs. PHAB+RAVE-O) (e.g., Morris et al., 2012). Students were taught in small groups of four, matched for word reading skill, and representing different race (Caucasian or Black), socioeconomic status (SES; Average or Low), and IQ (Average or Below Average) groups. The intervention groups met for 1 hour a day, 5 days a week, for a total of 70 instructional hours for each participant. Equal time was allocated to both

components in each condition, with 30 minutes per session devoted to the PHAB program and 30 minutes to the RAVE-O program, for example. Standardized measures of word and text reading were collected at the beginning, in the middle (after 35 hours), and at the end (after 70 hours) of the interventions, as well as at 1-year follow-up (e.g., Morris et al., 2012). The results indicate that the groups that received the multicomponent interventions outperformed the group that only received the phonological skills intervention (PHAB+CSS) on all basic reading skills, including word identification accuracy and efficiency and oral reading efficiency. Some differences were observed between the PHAB+RAVE-O condition versus the PHAB+WIST condition after 70 hours of instruction, but these differences dissipated at the 1-year follow-up and equivalent long-term outcomes were reported (e.g., Morris et al., 2012).

Efficacy of the Abbreviated Intervention

Two studies have assessed the effectiveness of the abbreviated RAVE-O intervention to date. The first study implemented the intervention in a single-subject research design with four participants with reading difficulties (e.g., Schmidt, 2019). Three participants attended grade 4, and one participant was in grade 3 at the time of the intervention. In 15 small-group sessions that lasted 45 minutes each, the reading intervention was administered, along with progress monitoring measures of oral reading fluency and reading comprehension. Pre- and post-test measures were collected and the percentage of non-overlapping data points was reported. The findings indicated that the abbreviated RAVE-O intervention improved students' reading skills, with small effects found for decoding accuracy and reading fluency and moderate effects found for decoding fluency and comprehension skills (e.g., Schmidt, 2019).

Another study investigated the effectiveness of the abbreviated RAVE-O program in conjunction with Dino Island, an intervention aimed at attention and executive functions (e.g., Lewis et al., 2019). Intervention sessions combined 12 hours of RAVE-O intervention and 12

hours of Dino Island, so that a total of 24 hours of intervention was given in two 1-hour sessions per week for 12 weeks. The participants included in this study were 11 children of elementary-school age with diagnosed reading disabilities. Lewis et al. (2019) reported that the participants showed significant improvements in word reading ability from pre- to post-test, and upward trends were observed for reading comprehension. These two studies show support for the effectiveness of an abbreviated version of the RAVE-O intervention. Together with the findings from the research on the full RAVE-O program (e.g., Morris et al., 2012) there is a robust body of work supporting the effectiveness of the RAVE-O program. Therefore, this intervention was selected for the study presented here.

The Present Study

The abbreviated RAVE-O program was adapted for synchronous online instruction through videoconferencing in the present study. The objectives of each of the 15 sessions were preserved in the adaptation. Opportunities for students to actively engage with the materials were integrated in the online sessions, as was teacher modelling and guided practice. The principles of effective instruction were used to guide the change to an online intervention, as well as the cited research on effective online interventions. Once the RAVE-O program was adapted for online remote instruction, a single-subject research design was implemented to investigate the effectiveness of a synchronous online Tier 3 fluency intervention. Progress monitoring measures were collected to inform instruction and to track changes in word reading and oral reading fluency and in reading comprehension. The following research questions were addressed: (1) Is the redesigned RAVE-O intervention for synchronous online instruction effective in increasing struggling readers' literacy skills and fluent comprehension? and (2) Can a reading intervention designed for in-person instruction be adapted to a synchronous online instruction model while maintaining the efficacy of the reading intervention?

Research Design

In order to answer the research questions, a single-subject research design was selected. Single-subject research methods have traditionally been used in special education research and are well-equipped to inform experimental research questions that assess the effectiveness of an intervention (Horner et al., 2005). Single-subject research is concerned with the causal or functional effect(s) of an independent variable on one or more dependent variables (Gall et al., 2014; Horner et al., 2005). The independent variable is often an intervention, and the dependent variables are measured before, during, and after the intervention has been implemented. The collected data is then analyzed and compared to see if the intervention had the desired effect on the behaviour or skills of the participant(s). Thus, the participant is their own control in this within-subjects design. If several participants are included, between-subjects comparisons can provide additional data, but generalizations to a larger population cannot be made due to the small sample size. The flipside of this disadvantage to single-subject research is that heterogeneous populations, such as students with low-incidence disabilities, are rarely the focus of experimental research that utilizes randomized-control trials (RCT; Horner et al., 2005). In single-subject research designs, the effectiveness of an intervention can be examined in relation to the specific learner profiles of the individual students that are hypothesized to benefit from the intervention. Furthermore, if the intervention is not as effective as hoped, the behaviour from non-responders can be analyzed in detail and inform how the intervention should be adjusted to have the desired effect on a larger group of students (Horner et al., 2005). Another advantage of single-subject research over RCT is that experimental effects can be examined under typical educational conditions. Interventions that are going to be implemented in a school-setting, should also be tested in a school-setting instead of in a clinical setting, for example. Moreover, single-

subject research is not only focused on the result of a change in behaviour or skill, but can also assess the process of change (Horner et al., 2005).

Method

Participants

Struggling readers in grades 2 to 5 were recruited to receive the RAVE-O intervention through the Centre for Outreach Education at the University of Victoria and through word of mouth in the teacher community in Victoria, BC. To determine eligibility to participate, screening measures were administered in an online, individual, pre-test assessment session. The Test of Word Reading Efficiency, Second Edition (TOWRE-2; Torgesen et al., 2012) Sight Word Efficiency (SWE) and Phonemic Decoding Efficiency (PDE) subtests were used to assess potential participants' reading fluency skill. Students that scored at or below one standard deviation below average were included in the present study. A specific learning disability or dyslexia diagnosis was not necessary for eligibility, but did not lead to exclusion from the study. Students whose first language was not English were not eligible to participate in the study. In total, six children were screened out of the study because they did not meet the eligibility criteria. Three children were older than the specified age range, and one child was withdrawn from the study before the screening session could take place due to scheduling conflicts. Two more children completed the pre-test screening session and were found to have age-typical reading skills, as assessed with the TOWRE-2 SWE and PDE subtests. Therefore, they were excluded from the study after the pre-test session.

A total of four children met the eligibility criteria to participate in the RAVE-O intervention sessions. One of those children received the first three intervention sessions, but unfortunately the intervention had to be discontinued due to a change in the researcher's personal circumstances. The remaining three children received the full intervention and completed the

post-test assessment session. Two of those three children, Mitchell and Emma[1], were reading at a similar level and were paired together to receive the intervention in a small-group design, as was originally planned. The third student, Sophie, was not yet reading in English and no other participant could be found in time to pair her up with, so she received the RAVE-O intervention in individual sessions. All three participants experienced difficulties in reading; no other comorbidities were reported.

Mitchell was an 8-year-old boy in grade 3. He was diagnosed with a Specific Learning Disorder (SLD) in reading in January of 2021. Some of the tests that were included in this study's pre-test battery, including the TOWRE-2 screening measures, were already administered by the school psychologist in January 2021. Thus, Mitchell's standardized scores and percentile ranks on those tests were sent to the researcher, with approval from the parents, so that those subtests did not have to be administered again so soon after the psychoeducational assessment. During the intervention, Mitchell attended school in-person and did not receive any additional reading support other than the regular classroom instruction.

Emma was a 7-year-old girl in grade 2 French Immersion. Her mother heard about the study through word of mouth and signed her daughter up because Emma was having difficulty reading in English. In school, where Emma learned to read in French, she was evaluated as 'approaching expectations' in her literacy skills throughout Kindergarten and grade 1. In the first term of grade 2, Emma was 'not yet meeting expectations' in reading. Concurrently with the RAVE-O intervention, Emma received reading support at school once a week and also read with a grade 12 tutor twice a week after school through the Je Lis program, for a total of 65 minutes of extra reading support in French weekly. The language spoken at home was English. Emma's

[1] Pseudonyms were used for all three participants in this study.

standardized scores on the screening measures were more than one standard deviation below average, so based on these scores and her history of reading difficulties, the decision was made to include Emma in the present study. During the intervention, Emma attended school in-person.

Sophie was an 8-year-old[2] girl in grade 2 French Immersion. Her teacher had heard about the study through word of mouth and recommended Sophie for participation, as Sophie was reading around a level 2 PM benchmark in French and struggled with blending sounds, decoding words, and acquiring sight words. The language spoken at home was English. On the SWE screening measure, Sophie was not able to read any words correctly, so a standard score of 55 was recorded. On the PDE screening measure, Sophie was not able to decode any of the practice items correctly, so testing was discontinued and a standard score of 58 was recorded. This made her eligible to participate in the study. During the intervention, Sophie received some reading support in school in addition to the regular classroom instruction, but she was also kept home from school for the first three weeks of the intervention due to a rise in COVID-19 cases in the region. During this time, Sophie did not receive extra reading support other than the online RAVE-O intervention. Sophie returned to school at the beginning of May, in the fourth week of the intervention.

Measures

Pre-test and post-test measures were collected to allow comparison of students' reading skills before and after the intervention. The RAVE-O program was a fluency intervention, and thus word reading fluency and decoding fluency were two dependent variables. The underlying skills of phonological awareness and naming speed were also assessed to examine the effectiveness of the RAVE-O intervention when implemented in a synchronous online

[2] Sophie was 7 at the time of the pre-test assessment and turned 8 during the intervention phase.

environment. To differentiate between reading accuracy and fluency, untimed measures of word reading and decoding were collected. Reading comprehension was the last dependent variable, as it represented the ultimate goal of reading instruction. All measures used at pre-test and post-test were norm-referenced tests that were delivered in a standardized format that was adapted for online delivery. The students viewed the standard test pages on their computer or tablet screen and the researcher followed the standard script to administer the subtests to the students.

Curriculum-based measures (CBMs) were administered weekly during the intervention to monitor Mitchell and Emma's progress on oral reading accuracy and fluency and on reading comprehension. Sophie's word reading accuracy and fluency were assessed weekly during the intervention, as she was not able to read connected text yet.

An implementation fidelity checklist was created for this study to assess whether the online RAVE-O intervention was adapted and implemented with fidelity.

Phonological Processing

The Elision subtest from the Comprehensive Test of Phonological Processing, Second Edition (CTOPP-2; Wagner et al., 2013) assessed phonological skill. The researcher orally presented a word that the students had to repeat and then manipulate by removing phonemes from the original word to create a new word. Starting and stopping points as reported in the test manual were followed. An average internal consistency coefficient of .91 was reported for the Elision subtest.

Naming Speed

The Rapid Letter Naming (RLN) and Rapid Digit Naming (RDN) subtests from the CTOPP-2 were administered to assess naming speed. Students were presented with a PowerPoint slide on which the scanned test page was shown. On the test page, six different letters for the RLN or six different numerals under 9 for the RDN were printed in random order, in four rows of

nine items. The participants were then asked to name the letters or digits as fast and as accurately as they could. Internal consistency reliability coefficients were reported as .85 for the RLN subtest and .87 for the RDN subtest (Wagner et al., 2013).

Accuracy

To assess word reading accuracy, the Letter-Word Identification (LWI) subtest of the Woodcock-Johnson Test of Achievement, Fourth Edition (WJ-IV; Schrank et al., 2014) was administered. The LWI task was a context-free word recognition task that required students to read aloud a list of real words that increased in difficulty. To assess decoding accuracy, the Word Attack (WA) subtest of the WJ-IV was administered. The WA task required students to apply their letter-sound knowledge to decode pseudowords. Basal and ceiling rules as reported in the test manual were applied and raw scores, standard scores and percentile ranks were recorded. Alternate forms (A and B) were used at pre-test and post-test, respectively. The LWI subtest has a median internal consistency reliability of .92 for students aged 5-19 and the WA subtest has a median internal consistency reliability of .90 for 5-19 year-olds (Mather & Wendling, 2014).

Fluency

Participants' fluent word reading and decoding skills were assessed by the TOWRE-2 SWE and PDE subtests. These tests required participants to read as many real words and pseudowords, respectively, as possible in 45 seconds. Test-retest reliability coefficients for children aged 8-12 years were reported as .90 for the SWE subtest and .89 for the PDE subtest (Torgesen et al., 2012). Alternate forms (A and B) were used at pre-test and at post-test, respectively.

Reading Comprehension

The Passage Comprehension subtest from the WJ-IV (Schrank et al., 2014) was administered to assess reading comprehension. This was a cloze task that required students to fill

in the blank in a sentence or short passage with a fitting word. Basal and ceiling rules as reported in the test manual were applied and raw scores, standard scores and percentile ranks were recorded. Alternate forms (A and B) were administered at pre-test and post-test, respectively. The Passage Comprehension subtest has a median internal consistency reliability of .89 for students aged 5-19 (Mather & Wendling, 2014).

Progress Monitoring Measures

The CBM Oral Reading Fluency (ORF; Good & Kaminski, 2002) assessed Mitchell and Emma's oral reading accuracy and fluency while they read a passage of connected text for one minute. Nine alternate forms were used in this study so that the participants read a new passage of similar difficulty each week. The number of total words read, the number of errors, and the number of words read correctly were recorded for each passage, as well as an accuracy score in percentages (number of words correct / number of total words read x 100).

The CBM Maze measure (University of Oregon, 2020) was the progress monitoring measure that was used to assess Mitchell's and Emma's reading comprehension during the intervention. It required students to read a passage in which every seventh word was omitted from the sentences. Students were presented with three choices to fill in the missing word. Students had three minutes to choose as many correct words as possible. The number correct and number incorrect were recorded at each administration, as well as the adjusted score (number correct – (0.5 x number incorrect)). Because there were only six different Maze passages available at the grade 2 level, students received alternate forms for the first six weeks and repeated the first two (Mitchell[3]) or three (Emma) forms in weeks 7, 8 and 9 of the intervention.

[3] Mitchell missed a lesson in week 6, which meant that the progress monitoring measures were collected on one more occasion for Emma than for Mitchell.

The CBM Word Reading Fluency (WRF; University of Oregon, 2020) was used to assess Sophie's word reading accuracy and fluency during the intervention. The WRF measure consisted of a list of frequently used words and increased in difficulty within each alternate form. Sophie was asked to read as many words as she could in one minute, and the number of words read correctly was recorded after each administration. Eight Kindergarten-level forms were used to monitor Sophie's progress in word reading accuracy and fluency.

Implementation Fidelity Checklist

An implementation fidelity checklist (see Appendix A) was created to ensure that the online RAVE-O intervention was adapted with fidelity from the in-person abbreviated RAVE-O intervention and implemented in a similar fashion for all students and across all lessons in the present study. The script for the abbreviated RAVE-O intervention (Harrison et al., 2017) was perused and components that recurred in each RAVE-O lesson were identified. These components were then listed in the implementation fidelity checklist to ensure that these activities were included in each online RAVE-O lesson. Aspects of effective instruction were also included in the checklist, to ascertain that the researcher paid attention to these elements in each online session.

Eight recurring components of the RAVE-O intervention (i.e., warming-up, *core words*, *MIMs*, sound blending, worksheets, *Eye Spy words*, *Minute Story*, and the *RAN chart*) were included in the implementation fidelity checklist as well as four aspects of effective instruction (engaging students, verbatim script, answering questions, appropriate conclusion). Items were scored on a 0-2 range, with a score of 0 meaning that the component was not addressed in the lesson, and a score of 2 meaning that the component was fully covered in the lesson. Because Mitchell and Emma received the intervention together, one implementation fidelity checklist per session was completed for them as a pair.

On the implementation fidelity checklist, the date and lesson number were recorded, as well as the duration of each session. At the beginning of each session, students were asked if they wanted to work with the researcher that day and an affirmative response indicated ongoing participant consent. If any technical errors or other issues occurred during an intervention session, that information was also recorded on the implementation fidelity checklist. At the end of each session, students were asked what they had liked and what they had disliked about that day's lesson. Student answers were written down after the conclusion of the lesson. The researcher completed the implementation fidelity checklist immediately after each session and wrote a general comment about the lesson as well.

Materials

Fifteen RAVE-O lessons were initially created in PowerPoint, reflecting the script used by Harrison et al. (2017). During the Zoom sessions, the researcher shared the PowerPoint slides via Zoom screen share, which the students viewed on their home laptops or tablets. A physical copy of the RAVE-O workbook with the relevant worksheets for each lesson was mailed to the participants before the start of the intervention. The students worked in their workbooks during each online intervention session to ensure active engagement in the lesson and to facilitate interaction with the materials.

RAVE-O Components

Each RAVE-O lesson included eight recurring components and used the following order sequence of activities: (1) warming-up activity; (2) introduction of new *core words*; (3) explanation of the meanings of the *core word*; (4) segmenting and blending the sounds in the *core word*; (5) practice writing the *core word* in workbook; (6) introduction of the *Eye Spy* words; (7) repeated reading of the *Minute Story*; (8) administration of the *RAN chart.* A description of each of these activities follows:

1. Warming-up: Each lesson began with a short warming up activity, in which the students took turns reading all the *core words* collected on the *Word Wall* so far.
2. Introduction of new *core words*: Four to six new *core words* were introduced in each RAVE-O lesson and added to the *Word Wall.*
3. Explanation of meanings: The *core words* in the RAVE-O program were specifically selected because they have many different meanings. In this activity, each *core word*'s *Many Interesting Meanings* (*MIMs*) were explained to the students. This activity is intended to increase the participants' vocabulary (for example, one *core word* was 'bat', which can be the nocturnal animal, or the object that is used in baseball to hit the ball, or the action of hitting the ball with a bat).
4. Segmenting and blending: The sounds in each *core word* (e.g., /b/ /a/ /t/) were identified and then blended together again to make the *core word*. Students were also asked to determine if *core words* rhymed with each other (e.g., bat rhymed with pat) and if they could think of other words that rhymed with the *core word* in this activity. This in-depth exploration of the sounds of each *core word* improved the strength of the orthographic mapping between the letters of the word and its phonology (i.e., how the word sounds; Wolf, 2011).
5. Writing practice: This activity focused on the rhyming patterns and spelling of each *core word*. For each *core word*, the *rime family* was identified (e.g., 'at' in the *core word* bat), and students practised writing the *rime pattern* and then the whole *core word* in their workbooks.
6. *Eye Spy* words: Before the reading of the *Minute Stories*, new *Eye Spy* words were introduced in each lesson. These words were among the most frequently used words in

the English language and often did not have regular letter-sound correspondence, such as *is, has,* and *she*.

7. Reading of *Minute Story:* Another activity that was a reoccurring feature in the RAVE-O lessons was the reading of a *Minute Story*. These short stories were specially written for the RAVE-O and focused on the four to six *core words* introduced in each lesson. The *core words* were repeated often in the *Minute Stories,* and in such a way that different meanings of *core words* could be identified within one story. Repeated readings of the *Minute Stories* took place in each lesson, to improve children's reading accuracy and fluency. For example, in the paired administration with Mitchell and Emma, each student took a turn reading the lesson's *Minute Story* while the other student listened or worked on an activity in their workbook (e.g., highlighting the *core words* in the *Minute Story*). In the individual administration with Sophie, the researcher often modelled fluent reading, after which Sophie read the *Minute Story* by herself.
8. *RAN chart:* A last component of each RAVE-O lesson was the *RAN chart* activity, in which students practiced reading the *core words* accurately and swiftly in a reflection of a RAN test (where students have to identify single letters or numbers as fast as they can). This activity was often skipped due to timing considerations, but implemented frequently in later lessons with Sophie to increase her automaticity in word recognition.

Online Delivery: Materials and Resources

The PowerPoint lessons were created based on the abbreviated script by Harrison et al. (2017). Examples of some of the PowerPoint slides from lesson 8 are included in Appendix B. Each PowerPoint lesson started with an image of the RAVE-O town to welcome the students to

the lesson. The next slide would show the growing *Word Wall,* with previously learned *core words* in black, and the new *core words* in different, bright colours. Colours were held constant throughout a lesson for the *core words*. Other key terms, such as *Ender Bender* and *Harder Starter,* were also coloured and would show up in the same colour in any subsequent lessons in which they appeared. This was intended to be a visual reminder for the students, as well as create engaging PowerPoint slides. To explain the *MIMs* of new *core words,* the RAVE-O program used *image cards* that depict the different meanings of the *core word*. These *image cards* were scanned and placed on a PowerPoint slide. Animated circles were drawn around each *image card* as its meaning was discussed during the lesson to draw the attention of the students to the right *image card*. The RAVE-O kit also included posters that reminded students of important tips and tricks, such as the *Rhyme Time tip* and the *Ender Bender tip*. These posters were available to download from the RAVE-O website and were also used in the PowerPoint lessons. Similarly, the worksheets from the RAVE-O workbooks were shown on the PowerPoint slides when students were required to work in their workbooks. These screenshots were included so that students could easily check whether they had the right page in their workbooks, and allowed the researcher to indicate how they were supposed to complete the worksheet. Any instructions that were written down on the PowerPoint slides were also conveyed orally to the students. The students were not expected to read these instructions, since that would cause unnecessary strain on their cognitive capacity. As the intervention progressed and the researcher grew more comfortable with using Zoom, the Zoom Annotate functions were used to fill out the worksheets on the screen while the students were working on their physical worksheets. This allowed the researcher to instruct the students even better. Another important component of the RAVE-O program was the *Minute Stories*. These stories were adapted for online instruction by screenshotting the pdf of the Minute Story Anthologies and pasting the pages with the *Minute*

Story in the PowerPoint. This allowed the students to read along with each *Minute Story* on their computer screen and did not necessitate the distribution of the storybooks to the participants. Using a laser pointer in PowerPoint, the researcher would follow along with the students, pointing to each word as they read it. Many slides were kept constant throughout each RAVE-O lesson, only changing the relevant *core words* and *rime patterns*. Visual cues, such as coloured words, animations, and the laser pointer, were used in abundance to keep the students engaged throughout the lessons. Activities on the screen were interchanged with activities in the workbooks, so that students were actively participating in the lessons. The RAVE-O materials were incorporated in the PowerPoint lessons as much as possible to stay close to the original intervention.

Procedure

Administration of screening and pre-test measures took place individually, in one synchronous online videoconferencing session of one hour. After eligibility checks, the intervention was implemented with the selected students, in small-group or paired administration (1:2) videoconferencing sessions for Mitchell and Emma, and in individual administration (1:1) for Sophie. The videoconferencing application used for all sessions was Zoom, which allowed the researcher to interact in real time with the students. Device webcams were turned on during the lessons for the researcher and for the participants. The researcher was in a quiet room and used earbud headphones during all Zoom sessions to create an environment without distractions. Sessions took place twice a week and lasted, on average, 70 minutes.

Approximately once per week, the progress monitoring measures (ORF and Maze for Mitchell and Emma; WRF for Sophie) were administered to track the students' progress in oral reading fluency and comprehension (Mitchell and Emma) and word reading fluency (Sophie). After the last intervention session, the researcher met the students once more in an individual

Zoom session to administer the post-test measures. Both pre-test and post-test sessions lasted no longer than 60 minutes. The implementation fidelity checklist was completed by the researcher after every intervention session and a short written summary of the session was also recorded.

Parental Involvement

Since the researcher was not present in the same room as the participants, a certain level of parental or guardian supervision was required. The students' parents were initially asked to only assist their child with signing in to the Zoom sessions and with any technological issues that occurred. However, the level of parental involvement ended up being more than expected due to the online nature of the intervention. It was difficult for the researcher to properly support the children with their worksheets through a screen, so the students' mothers often assisted them with completing the worksheets, giving instructions on where to write and how to form letters. These worksheets were not collected after the intervention or analyzed, but were used to actively engage the students during the lessons. The parents prompted students to stay focused and provided emotional support when their children needed it, but did not provide the answers for the students during pre- and post-testing nor during the intervention sessions.

Mitchell needed much prompting to maintain his focus during the intervention sessions; thus, his mother needed to be present during the intervention sessions to encourage him to pay attention and stay on task. Emma also preferred to have her mother sitting next to her during all Zoom sessions, but needed minimal prompting to stay on task. Sophie, on the other hand, benefitted from less parental involvement. She was more focused if her parent was not in the same room, and because Sophie received individual intervention sessions it was possible for the researcher to ensure on-task behaviour and to properly support Sophie with completing her worksheets.

Adjustments to Lessons

It was estimated that each of the fifteen RAVE-O lessons would take 30-45 minutes. However, it quickly became apparent that each session lasted at least one hour, often even longer. The lessons also increased in length and in the number of activities as the intervention went on, so some activities had to be skipped during the Zoom sessions. Several of the later RAVE-O lessons were too long, and thus split across two sessions. The adjustments made to the lessons were different for each type of administration and are detailed below.

Paired Administration. For students Mitchell and Emma, who received the intervention as a pair, RAVE-O lessons 1 through 10 were taught in singular Zoom sessions. Then, lesson 11 was split up, creating lesson 11a, which was followed by lesson 11b12a, which included the last part of lesson 11 and the first part of lesson 12. Then lesson 12b13a was taught, and lesson 13b followed after that. Lessons 14 and 15 were taught in singular sessions again, although some of the activities in those lessons were skipped (e.g., the *RAN chart* activity).

Due to one absence and one change in availability, Mitchell received a total of 16 intervention sessions, of which one lesson was individually. Emma received a total of 17 intervention sessions, of which two were individually, and one of those was a review of lesson 10 due to Mitchell's absence. This way, both students received all of the RAVE-O lessons and Mitchell did not miss lesson 11, which introduced *Harder Starters* and an important progression to reading words quicker.

Individual Administration. For the third participant, Sophie, it became apparent around lesson 5 that the activities in the RAVE-O intervention were increasing in difficulty faster than Sophie was acquiring the necessary skills to complete the activities in a timely manner. Sophie had to practice the *core words* and their sounds extensively before she was able to read the *core words* (semi-)automatically, without having to sound them out first. Moreover, her retention rates

were low: For example, CVC words with vowel *i* were introduced in lessons 4 and 5, then CVC words with vowel *o* were learned in lesson 6, and upon reading lesson 6's *Minute Story* Sophie was able to read the *o*-words but not the *i*-words. It would also take her up to 30 minutes to read a *Minute Story*, which are meant to be read in one minute. Because of the slower pace that needed to be kept throughout the sessions, lesson 6 was not completely finished in one Zoom session. Hence, the 7th session started with lesson 6's *Minute Story* and continued with the first part of lesson 7 (i.e., this became lesson 6b7a). Session 8 was the continuation of RAVE-O lesson 7. All of RAVE-O lesson 8 was taught in the 9th session, which took 90 minutes. Because of this, the researcher decided to break the lessons down for Sophie, as it was more important to teach the *core words* and their sounds to mastery rather than get through all 15 RAVE-O lessons with Sophie. Session 10 consisted of the first part of RAVE-O lesson 9, and the second half of lesson 9 was taught in session 11. Sessions 12 and 13 consisted of RAVE-O lesson 10a and 10b respectively. In RAVE-O lesson 11 words with *Harder Starters* were introduced, which are words that start with two or even three consonants, such as *plan*, *frog*, and *struck*. Since Sophie had not yet mastered reading the CVC and CVCe *core words* automatically, the decision was made to not continue past RAVE-O lesson 10 with Sophie. Instead, all *Magic-e* core words (i.e., CVCe words such as *cane*, *fine*, *note*, and *cube*) were reviewed in session 14 and lesson 6's *Minute Story* was read. In session 15, the core words with vowel *u* were reviewed and lesson 7's *Minute Story* was read.

Results

Analysis

The collected data was analyzed to examine the efficacy of the implemented intervention. First, pre- and post-test standard scores and percentile ranks were compared for each participant. All raw scores on the norm-referenced tests were converted to a scaled score (with $M = 10$ and

SD = 3 on the CTOPP-2) or a standard score (with *M* = 100 and *SD* = 15 on the TOWRE-2 and WJ-IV). For ease of reporting, the CTOPP-2 scaled scores were converted to standard scores. Standard scores between 90 and 110 denote age-typical or average performance and correspond with percentile ranks of 25 and 75 respectively.

Then, data from the ORF, Maze, and WRF progress monitoring measures were reported for each student and examined visually for trend development and variability for each student. Additionally, the percentage of non-overlapping data points (PND) between the baseline and intervention phases was calculated to provide a quantitative measure of the efficacy of the intervention (Scruggs, Mastropieri & Casto, 1987; Olive & Franco, 2008). PND is a frequently used method to quantify single-subject research designs because it allows for an objective approach, in addition to the subjective visual trend analyses, and it allows researchers and practitioners to easily interpret the results of an intervention. To compute the PND, the highest baseline score is identified. The data points in the treatment or intervention phase that exceed this highest baseline score are considered the non-overlapping data points. This number is divided by the total number of data points in the intervention phase and multiplied by 100 to get the percentage of non-overlapping data points (Scruggs et al., 1987). Scruggs and Mastropieri (1998) suggested the following criteria to interpret the effectiveness of a treatment: PND scores above 90 represent an intervention that is very effective, PND scores between 70 and 90 indicate an effective intervention, PND scores between 50 and 70 indicate a questionable or small intervention effect, and PND scores below 50 represent an ineffective intervention. These criteria were used to interpret the effectiveness of the RAVE-O fluency intervention for each of the three participants in this study.

Lastly, the data from the implementation fidelity checklists was compiled and analyzed. The checklists were used to check whether eight recurring components of the RAVE-O

intervention as well as four aspects of effective instruction were implemented with fidelity in each intervention session. The implementation fidelity data is organized by type of administration (paired or individual), as the dependent variable that was reported relates to how well the RAVE-O components were implemented in each lesson by the researcher, and not how well the individual students responded to the intervention. Hence, this data was analyzed at the administration level, because Mitchell and Emma received the (majority of the) intervention together in a small-group format and thus received the same lessons with the same implementation fidelity. Sophie received the intervention in a one-on-one format, and thus the intervention was administered individually for Sophie.

The results are reported in this same order: First, pre- to post-test comparisons are made for each student. Then, the data for the progress monitoring measures is reported in tables and graphically and the PNDs are computed for each student. Lastly, the results from the implementation fidelity checklists are presented for the paired administration first and then for the individual administration. A section summary concludes the results.

Pre- to Post-Test Comparison

Mitchell

Mitchell received a total of 1105 minutes of intervention over 16 lessons (M = 69.1, SD = 10.4), which equals 18.4 hours of intervention. Table 1 shows Mitchell's pre- and post-test standard scores and percentile ranks on the eight norm-referenced subtests used in this study. Pre-test scores were collected on two separate occasions for Mitchell, as explained in the Methods section. The TOWRE-2 and CTOPP-2 subtests were administered in person by a trained school psychologist in January 2021, while the WJ-IV subtests were administered online by the researcher in March 2021. Post-test scores were collected in one single online Zoom session at the beginning of June 2021 by the researcher.

On the fluency measures (SWE and PDE), Mitchell's standard scores decreased slightly, indicating worse performance at post-test. On the Elision and RLN subtests Mitchell's score stayed the same, indicating no change in his phonological skills or naming speed skills. On the accuracy measures (LWI and WA), however, Mitchell's score increased, as did his score on the comprehension measure. This indicates that Mitchell's reading fluency did not improve but his accurate decoding and word reading skills increased. The increase in standard score on the LWI subtest is notable because a standard score of 79 falls well below average, while a standard score of 84 falls below average. This is an educationally relevant improvement in Mitchell's decoding skill.

Table 1

Mitchell's Pre-test and Post-test Scores

Reading Skill Measure	Phase			
	Pre-test		Post-test	
	Standard Score	Percentile Rank	Standard Score	Percentile Rank
TOWRE-2				
Sight Word Efficiency	75	5	74	4
Phonemic Decoding Efficiency	76	5	73	3
CTOPP-2				
Elision	85	16	85	16
Rapid Digit Naming	80	9	85	16
Rapid Letter Naming	85	16	85	16
WJ-IV				
Letter-Word Identification	79	8	84	14
Word Attack	82	11	86	18
Passage Comprehension	81	11	88	20

Note. TOWRE-2 = Test of Word Reading Efficiency, Second Edition; CTOPP-2 = Comprehensive Test of Phonological Processing, Second Edition; WJ-IV = Woodcock-Johnson Test of Achievement, Fourth Edition.

Table 2

Emma's Pre-test and Post-test Scores

Reading Skill Measure	Phase			
	Pre-test		Post-test	
	Standard Score	Percentile Rank	Standard Score	Percentile Rank
TOWRE-2				
Sight Word Efficiency	70	2	78	7
Phonemic Decoding Efficiency	78	7	87	19
CTOPP-2				
Elision	90	25	105	63
Rapid Digit Naming	75	5	80	9
Rapid Letter Naming	90	25	85	16
WJ-IV				
Letter-Word Identification	79	8	82	11
Word Attack	92	30	95	36
Passage Comprehension	86	18	88	20

Note. TOWRE-2 = Test of Word Reading Efficiency, Second Edition; CTOPP-2 = Comprehensive Test of Phonological Processing, Second Edition; WJ-IV = Woodcock-Johnson Test of Achievement, Fourth Edition.

Emma

Emma received a total of 1205 minutes of intervention over 17 lessons (M = 70.9, SD = 8.9) which equals 20.1 hours of intervention. Table 2 shows Emma's standard scores and percentile ranks on the eight norm-referenced subtests that were administered at pre-test in March 2021 and at post-test in June 2021. Emma improved her scores from pre-test to post-test on all measures except for the RLN subtest. Her standard scores on the untimed accuracy measures (LWI and WA) were higher than her standard scores on the timed fluency measures (SWE and PDE) at pre-test and at post-test, indicating that Emma was better able to decode and read words accurately when given the time to read words at her own pace. Her scores on the untimed decoding measure fell within the average range at pre- and at post-test, but Emma's fluent decoding skills were still below average at post-test. Nevertheless, both her accurate and fluent

decoding and word reading improved from pre- to post-test, indicating that the online RAVE-O fluency intervention was effective in increasing Emma's reading skills. On the PDE subtest and on the LWI subtest, Emma's standard scores were well below average at pre-test; at post-test, Emma's performance on these two subtests had increased so that the standard scores now fell in the below average range, indicating an educationally relevant improvement in fluent decoding and in accurate word reading.

Sophie

Sophie received a total of 1110 minutes of intervention over 15 lessons (M = 74.0, SD = 7.1) which equals 18.5 hours of intervention. Table 3 shows Sophie's standard scores and percentile ranks on the eight norm-referenced subtests that were administered at pre-test in March 2021 and at post-test in July 2021. On the SWE, Elision, and RDN subtests, Sophie's standard score did not change from pre- to post-test. However, the unchanged SWE standard score might obscure a small increase in Sophie's word reading fluency due to a floor effect. At pre-test, Sophie was unable to read any words correct on the SWE and PDE fluency subtests and scored below the first percentile for her age. At post-test, Sophie read six words correct in 45 seconds on each subtest, which indicates a small improvement in her fluent word reading and decoding skills, but this increase in fluent word reading was not large enough to lead to a higher standard score on the SWE subtest at post-test. Moreover, Sophie's standard scores improved on the accurate and fluent decoding (WA and PDE), the accurate word reading (LWI), and the reading comprehension subtests. The largest increases were seen on the PDE subtest, on which Sophie improved with 12 standard score points, and on the LWI subtest, on which Sophie improved with 17 standard score points. While Sophie's reading skills still showed serious deficits at post-test, it seems that the online RAVE-O intervention was effective in improving her accurate and fluent decoding, accurate word reading, and reading comprehension skills from pre- to post-test.

Table 3

Sophie's Pre-test and Post-test Scores

Reading Skill Measure	Phase			
	Pre-test		Post-test	
	Standard Score	Percentile Rank	Standard Score	Percentile Rank
TOWRE-2				
Sight Word Efficiency	55	<1	55	<1
Phonemic Decoding Efficiency	58	<1	70	2
CTOPP-2				
Elision	80	9	80	9
Rapid Digit Naming	85	16	85	16
Rapid Letter Naming	90	25	85	16
WJ-IV				
Letter-Word Identification	49	<0.1	66	1
Word Attack	74	4	76	5
Passage Comprehension	53	<0.1	61	0.4

Note. TOWRE-2 = Test of Word Reading Efficiency, Second Edition; CTOPP-2 = Comprehensive Test of Phonological Processing, Second Edition; WJ-IV = Woodcock-Johnson Test of Achievement, Fourth Edition.

Progress Monitoring Measures

Progress monitoring measures were collected once a week to assess the students' reading skills during the intervention. Mitchell and Emma received the ORF and Maze measures, while Sophie received the WRF measure due to her lower reading skills. The ORF measure assessed oral reading accuracy and fluency, the Maze measure assessed reading comprehension, and the WRF measure assessed word reading fluency. The administration of the progress monitoring measures took place individually at the end of the intervention sessions, except for the first collection, which was administered at the beginning of the first intervention session, when the intervention had not started yet. Thus, this first data point represented a baseline of the students' reading skills to which the other data points from subsequent administrations were compared.

Mitchell

Progress monitoring measures were collected on eight occasions for Mitchell due to an absence in week 6. Mitchell's scores on the ORF and Maze measures are shown in Table 4. His performance on the ORF measure is graphically depicted in Figure 1, while his scores on the Maze measure are shown in Figure 2. To calculate the PND for Mitchell's Total Words Correct score on the ORF, the data points that exceeded his first score of 42 were identified. Four of the seven subsequent data points were higher than 42, and thus the PND was calculated as 57.1%. With regard to Mitchell's accuracy score on the ORF measure, four out of seven data points did not overlap with his accuracy score of 91% in the first week, so the PND was calculated as 57.1%, which indicates a questionable effect of the intervention on Mitchell's oral reading accuracy and fluency. On the Maze measure, five of the seven data points exceeded the baseline score of 5.5 and thus the PND was 71.4%, which suggests that the intervention was effective in increasing Mitchell's reading comprehension skills.

Table 4

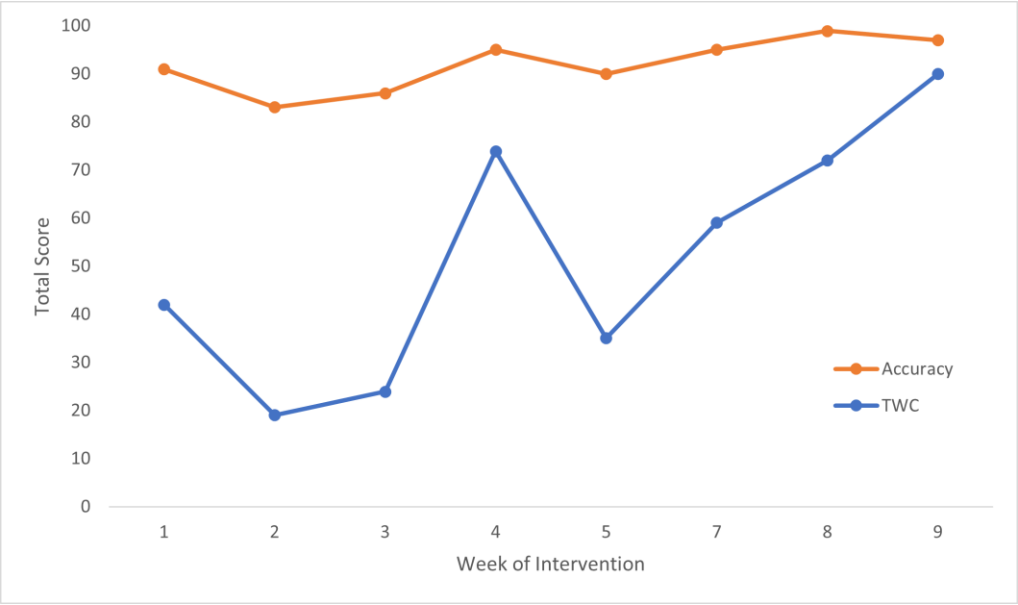
Mitchell's Performance on the Progress Monitoring Measures

Progress Monitoring Measure	Phase							
	Baseline	Intervention						Post
	Week 1	2	3	4	5	7	8	Week 9
Oral Reading Fluency								
Total Words Correct	42	19	24	74	35	59	72	90
Accuracy (in %)	91	83	86	95	90	95	99	97
Maze								
Adjusted Score	5.5	1	9	10	9.5	6	8	5.5

Note. No progress monitoring measures were administered for Mitchell in week 6 due to his absence. Total Words Correct is the amount of words read correctly in one minute. Accuracy is calculated as the amount of words read correctly divided by the total words read in one minute times 100. Maze Adjusted Score is calculated as number correct – (0.5 x number incorrect).

Figure 1

Mitchell's Oral Reading Fluency Scores

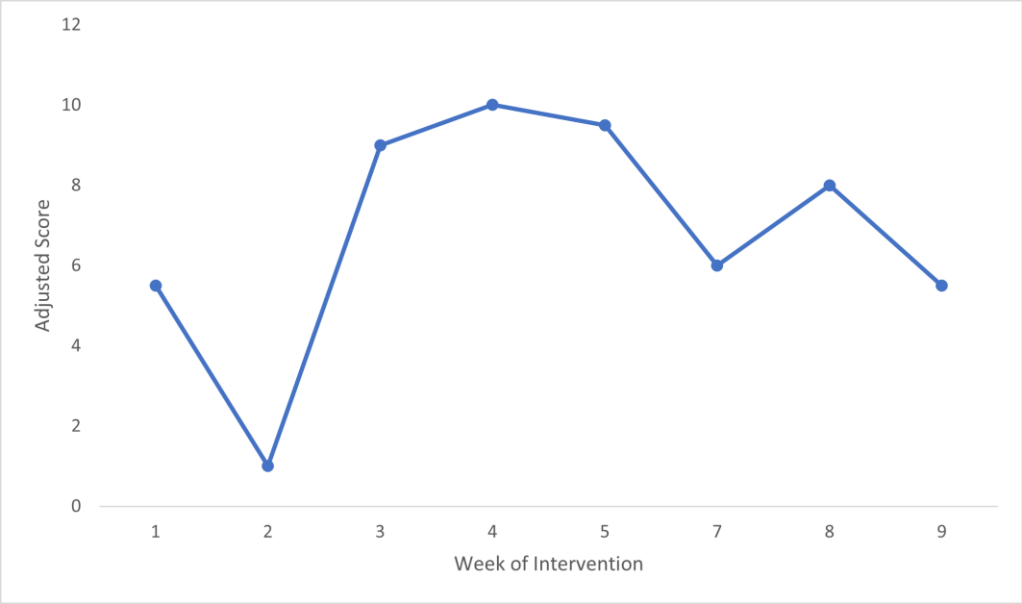


Note. The data collected in week 1 represented Mitchell's baseline score.

TWC = Total Words Correct.

Figure 2

Mitchell's Maze Score



Note. The data collected in week 1 represented Mitchell's baseline score.

Emma

Progress monitoring measures were collected on nine occasions for Emma. Her scores on the ORF and Maze measures are shown in Table 5. Emma achieved a baseline of 17 words correct on the ORF. On the subsequent administrations, six out of eight data points for Total Words Correct exceeded the first data point and thus a PND of 75% was computed, indicating an effective intervention. For Emma's accuracy score, a PND of 62.5% was calculated, as five out of eight data points exceeded the baseline of 81%. This PND score indicates a small intervention effect. On the Maze measure, Emma achieved a PND of 75%, which indicates that the RAVE-O intervention was effective in increasing Emma's comprehension skills. The positive effect of the RAVE-O intervention was also seen in the upward trends in Emma's reading fluency scores (see Figure 3) and in her reading comprehension scores (see Figure 4).

Table 5

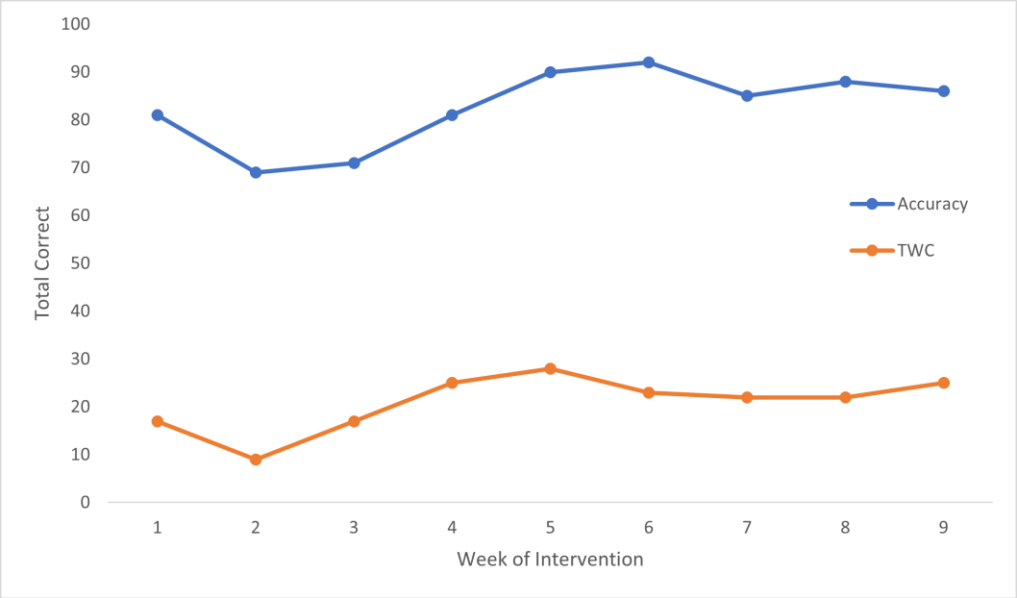
Emma's Performance on the Progress Monitoring Measures

Progress Monitoring Measure	Phase								
	Baseline	Intervention							Post
	Week 1	2	3	4	5	6	7	8	Week 9
Oral Reading Fluency									
Total Words Correct	17	9	17	25	28	23	22	22	25
Accuracy (in %)	81	69	71	81	90	92	85	88	86
Maze									
Adjusted Score	1	-0.5	1.5	1.5	3	2	0.5	1.5	2.5

Note. Total Words Correct is the amount of words read correctly in one minute. Accuracy is calculated as the amount of words read correctly divided by the total words read in one minute times 100. Maze Adjusted Score is calculated as number correct – (0.5 x number incorrect).

Figure 3

Emma's Oral Reading Fluency Scores

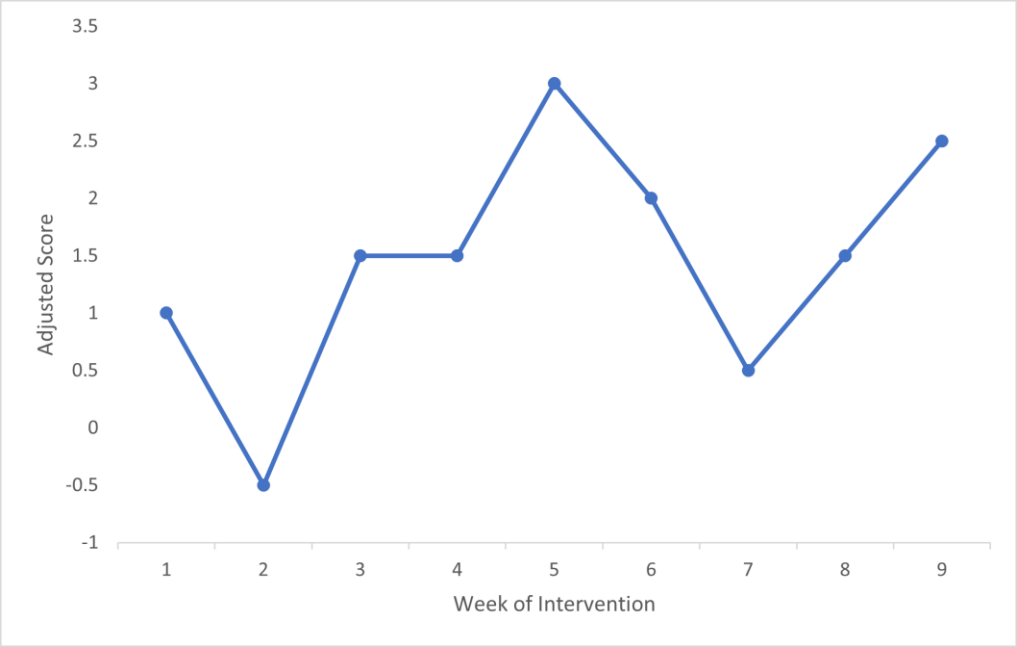


Note. The data collected in week 1 represented Emma's baseline score.

TWC = Total Words Correct.

Figure 4

Emma's Maze Score



Note. The data collected in week 1 represented Emma's baseline score.

Sophie

Progress monitoring data was collected on eight occasions for Sophie. Her scores on the WRF measure are shown in Table 6. Sophie achieved a baseline score of 2 on the WRF and four out of seven subsequent data points exceeded that baseline. Thus, the PND was calculated as 57.1%, which indicates a questionable intervention effect of the RAVE-O intervention on Sophie's word reading fluency skills. Figure 5 shows the variability in Sophie's WRF scores and does not show a clear upward trend.

Table 6

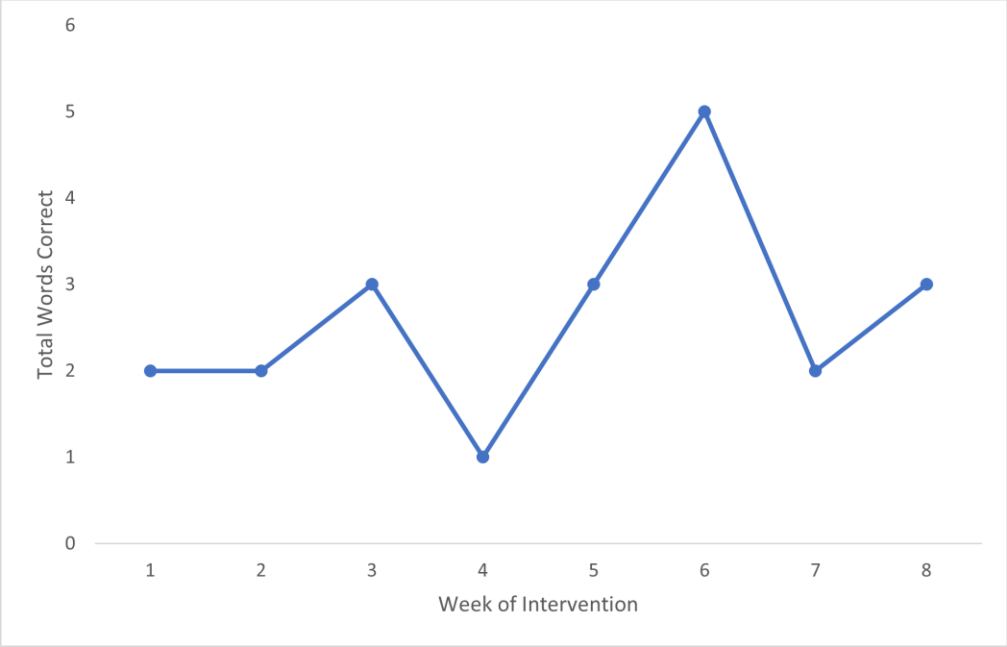
Sophie's Performance on the Progress Monitoring Measure

Progress Monitoring Measure	Phase							
	Baseline	Intervention						Post
	Week 1	2	3	4	5	6	7	Week 8
Word Reading Fluency								
Total Words Correct	2	2	3	1	3	5	2	3

Note. Total Words Correct is the amount of words read correctly in one minute.

Figure 5

Sophie's Word Reading Fluency Score



Note. The data collected in week 1 represented Sophie's baseline score.

Implementation Fidelity

The completed implementation fidelity checklists were analyzed to see whether the eight recurring components of the RAVE-O intervention (i.e., warming-up, core words, MIMs, sounds, worksheets, eye spy words, minute story, and the RAN chart) as well as four aspects of effective instruction (engaging students, verbatim script, answering questions, appropriate conclusion) were addressed in each intervention session. The participants rarely asked any questions during the sessions, so that item on the checklist was dropped before analysis.

Paired Administration

Mitchell and Emma received 15 intervention sessions together. Across all lessons for this pair, an average score of 1.59 (*SD* = 0.60) for the components part of the checklist was achieved. The components with the highest fidelity scores across all sessions for Mitchell and Emma were the *core words* and their *MIMs*, meaning that these components were always covered in the online lessons. The activity with the lowest score was the *RAN chart*, which was only completed in three sessions by Emma and Mitchell. With regard to the three items that assessed instructional elements, a mean score of 1.48 (*SD* = 0.26) was calculated for this pair, which indicates that the elements of effective instruction were appropriately used during the online lessons, although there was still some room for improvement.

Technical errors occurred in 7 of the 16 sessions, and ranged from minor issues with screen sharing to larger interruptions due to internet connectivity. The longest interruption took 10 minutes of lesson time away from the students in lesson 12.

The students were also asked at the end of each session what aspect of the lesson they liked best and if there was anything that they did not like about the online intervention session. Mitchell liked the reading of the *Minute Stories* best, and often answered that he liked everything

about the lesson and disliked nothing. Emma enjoyed working in her workbook most, especially if she got to use her highlighters. She also did not dislike any aspect of the RAVE-O lessons.

Mitchell received more overt parental support than Emma, as Mitchell's mother was visible and audible in the video during the intervention sessions while Emma's mother was not. However, Emma's mother was seated next to her during all intervention sessions, so the amount of time required from each parent was comparable. The participants and their families were not asked to complete worksheets or practice reading outside of the synchronous intervention sessions. During the administration of the progress monitoring measures, one of the students would be placed in a breakout room in Zoom while the other student stayed in the main room with the researcher. The participants would be instructed to complete a worksheet or to re-read the Minute Story while in the breakout room. Mitchell and Emma likely received parental support during this time, but no data was collected on the level of parental involvement, as the worksheets were not collected or analyzed. The parents did not provide answers for the students during the administration of the pre-test measures, post-test measures, and progress monitoring measures.

Individual Administration

Sophie received 15 individual intervention sessions. Across all sessions for Sophie, an average score of 1.60 (*SD* = 0.49) for the implementation fidelity of the components of the RAVE-O lessons was achieved. The component with the highest score was the *MIMs* activity, followed closely by the *core words* and *eye spy words* components. The component with the lowest score was the *RAN chart*, as it was only implemented once in the first session and on four more occasions in sessions 10, 12, 13, and 15. The instructional elements were implemented appropriately during the intervention sessions for Sophie, with an average score of 1.58 (*SD* = 0.21).

Technical issues occurred in 8 of the 15 Zoom sessions with Sophie, which means that more than half of the sessions were disrupted. Interruptions were often caused by issues with the internet connectivity or by screen viewing issues on Sophie's end, which were often easily solved by stopping the screen-share and starting it again, but sometimes Sophie's parent needed to provide assistance. No further parental support was required during the intervention sessions with Sophie. She was able to complete her worksheets and stay focused and on task without additional support from her parent.

Sophie liked the rhyming activities best across all lessons, but also enjoyed the *RAN chart* activity when it was implemented in later sessions. She did not dislike any aspect of the RAVE-O intervention.

Conclusion

To summarize, the synchronously implemented online RAVE-O intervention was effective in increasing the pre- to post-test accurate decoding and word reading skills and the comprehension skills of all three participants. More varied results were found on the fluency and naming speed measures. During the intervention, small intervention effects were seen on the ORF progress monitoring measure for Mitchell and on the WRF progress monitoring measure for Sophie. However, the intervention was effective in increasing Mitchell's and Emma's reading comprehension scores on the Maze measure. Emma also showed improvements during the intervention on her oral reading skills on the ORF measure, indicating that the RAVE-O intervention was effective in increasing her reading speed more so than her reading accuracy.

The online RAVE-O intervention was implemented with sufficient fidelity for all three participants, as average scores ranging from 1.59 to 1.60 were reported for the implementation of the RAVE-O components and average scores ranging from 1.48 to 1.58 were reported for the

effective instruction elements on the implementation checklist. The *core words* and *MIMs* activities, which were intended to teach the students new vocabulary, were most often addressed in the intervention sessions, while the *RAN chart* activity, which was meant to increase reading fluency, was least often implemented during the online RAVE-O intervention.

Discussion

In this study, the efficacy of a reading fluency intervention that was implemented in synchronous online intervention sessions with three struggling readers in grades 2 and 3 was examined. In 15 to 17 intensive intervention sessions, students' fluent and accurate word reading, fluent and accurate decoding, and reading comprehension skills were targeted by the online RAVE-O intervention. A single-subject research design was employed to answer the following research questions: (1) Is the redesigned RAVE-O intervention for synchronous online instruction effective in increasing struggling readers' literacy skills and fluent comprehension? and (2) Can a reading intervention designed for in-person instruction be adapted to a synchronous online instruction model while maintaining the efficacy of the reading intervention? The results of the study and the practical implications of the findings will be discussed for each research question, after which the limitations, future directions for research and the conclusion will follow.

The results found in the present study indicate that the online RAVE-O intervention was effective in increasing accurate word reading and decoding skills from pre- to post-test for all three participants. Furthermore, gains in reading comprehension from pre- to post-test were reported for all three participants. The PNDs reported for the Maze progress monitoring measure also indicate that the online RAVE-O intervention was effective in enhancing reading comprehension. These results are comparable with previous research on the efficacy of the RAVE-O fluency intervention. The original RAVE-O intervention was found to increase basic reading skills such as word decoding and oral reading fluency (e.g., Morris et al., 2012) and the

abbreviated in-person RAVE-O intervention was somewhat effective in increasing decoding accuracy and reading fluency skills and moderately effective in increasing decoding fluency and comprehension skills (e.g., Schmidt, 2019).

More specifically, the results from this study indicate that the synchronously implemented online RAVE-O intervention was effective in increasing struggling readers' accurate word reading and decoding skills as well as their comprehension skills. Mitchell improved his word reading and decoding accuracy on two untimed tests of word and pseudoword reading from pre- to post-test, but did not show the same increase on two timed tests of word and pseudoword reading, which indicates that the RAVE-O intervention was less effective in improving his word reading fluency and decoding fluency. The data collected during the intervention leads to the same conclusion, showing a small effect of the intervention on Mitchell's oral reading fluency, although upwards trends on the ORF progress monitoring measure could be seen when the data was presented graphically. Moreover, a moderate effect of the intervention on Mitchell's reading comprehension skills during and after the intervention was observed. Emma showed the best response to the intervention, improving on the word reading accuracy and fluency measures, on the decoding accuracy and fluency measures, and on the reading comprehension measure from pre- to post-test. The PND results indicated a moderate effect of the intervention on Emma's oral reading fluency and reading comprehension, although the effect of the RAVE-O intervention on her oral reading accuracy was small. Sophie showed improvements from pre- to post-test in her decoding accuracy and fluency, in her word reading accuracy, and in her reading comprehension. The RAVE-O intervention had a small effect on her word reading fluency during the intervention, although this was not reflected on the standardized word reading fluency measure (SWE) at post-test.

The implemented intervention had a limited effect on the fluency skills of the participants in this study, despite previous research finding positive effects on fluency skills (e.g., Morris et al., 2012; Schmidt, 2019). This could be due to the limited implementation of the intervention components that targeted fluent reading. The implementation fidelity data showed that the RAN chart activity was not included in most of the intervention sessions. The RAN chart activity included a worksheet with three rows of *core words* that the students were asked to read as quickly and as accurately as they could. The students were timed and then asked to read the list of words again, to see if their time improved on the second reading. This activity promoted fluent word reading skills that are necessary for proficient reading comprehension (see Wolf & Katzir-Cohen, 2001). This activity was often skipped because it required individual administration. During online interventions in Zoom, placing one student in a breakout room made it so that the researcher could not see that student anymore. It also took time to move students in and out of breakout rooms. Since the progress monitoring measures also had to be administered individually, the *RAN chart* activity was often skipped to reduce the amount of time students spent in breakout rooms and maximize the amount of time students received direct and explicit instruction. Furthermore, the timed rereading of the Minute Stories was also excluded from the online intervention sessions often, due to the constraints on individual administration in Zoom and the inclusion of the progress monitoring measures. This activity promoted oral reading fluency of connected text and the exclusion of this component could explain the limited effectiveness of the intervention on Mitchell's oral reading fluency skills. Sophie's oral reading fluency was not measured, as Sophie showed limited word reading and decoding skills at pre-test.

All three students showed an increase in their pre- to post-test reading comprehension skills and a moderate effect of the online RAVE-O intervention was found on the Maze progress monitoring measure for Mitchell and Emma. This effect could be due to the inclusion of the

MIMs component in all intervention sessions. Each lesson, the many interesting meanings of the *core words* were explained. All RAVE-O *core words* had at least two different meanings and some words had up to eight different meanings. On average, four interesting meanings were discussed for a *core word*. Some of these meanings were already known to the students, but some meanings were new to the students. This activity was thought to expand the students' vocabulary and also increase the associations with new meanings for known words. Previous research has shown the importance of vocabulary knowledge for reading comprehension (e.g., Ouellette & Beers, 2010; Tilstra et al., 2009; Tunmer & Chapman, 2012) and thus the increase in reading comprehension skills found in this study could be a result of the inclusion of vocabulary activities in each intervention session. However, vocabulary skills were not assessed in this study, so it is unclear whether the *MIMs* activity actually expanded the participants' vocabulary. Future research could assess whether the inclusion of *core words* with many interesting meanings in the RAVE-O intervention leads to a growth in vocabulary and, indirectly or directly, an increase in reading comprehension.

Reading comprehension is the ultimate goal of learning to read and has been said to require proficient decoding skills as well as language comprehension (Gough & Tunmer, 1986). Many foundational skills, such as phonological awareness, naming speed, and vocabulary knowledge, underlie these complex skills (e.g., Tunmer & Chapman, 2012; Wolf, Bowers, & Biddle, 2000) and many students require explicit instruction in these foundational skills before they can read and comprehend connected text (Kilpatrick, 2015). The RAVE-O intervention implemented in this study explicitly taught students phonological awareness, decoding, and vocabulary skills. Individual sounds in *core words* were identified and blended together, students were taught to look for common *rime patterns* in words to aid fluent decoding, and the many interesting meanings of *core words* were explained to enhance students' receptive and expressive

vocabulary. These activities resulted in improved performance on accurate word reading and decoding measures and on reading comprehension measures during and after the intervention, showing the effect of decoding accuracy and vocabulary knowledge on reading comprehension.

Knowing the specific areas of need of individual students can help educators and researchers choose or design appropriate interventions that specifically target the skills in which a student shows a deficit. When looking at the pre- and post-test scores of all three participants, Mitchell scored below average on most measures, showing deficiencies in his phonological skills as well as in his naming speed skills. Sophie showed mild to moderate deficiencies in her decoding and fluency skills and also scored below average on the naming speed measures. Based on the *Double Deficit* hypothesis (Wolf & Bowers, 2000), Mitchell and Sophie could be classified as the third subtype of readers with dyslexia with a double deficit in phonological processing and naming speed skills. Emma, however, did not show the same deficits in her phonological skills, as indicated by her average scores on the CTOPP-2 Elision and WJ-IV Word Attack subtests at pre- and post-test. Her naming speed skills at pre-test showed a more skewed picture, but were below average at post-test, indicating a small deficiency in naming speed. Emma's below average fluency scores could be explained by this deficit in naming speed despite her average phonological skills. Emma could be classified as a student with a single deficit in naming speed, based on the *Double Deficit* hypothesis (Wolf & Bowers, 2000). These findings also lend support to the theory that phonological skills and naming speed are two different processes, as posited by Wolf, Bowers and Biddle (2000). However, as was found in previous research (e.g., Georgiou et al., 2009; Lovett et al., 2000), naming speed skills were not improved by the implementation of the synchronous online reading intervention in this study. Future research could examine which intervention components or activities are effective in increasing naming speed skills.

To answer the second research question, an implementation fidelity checklist was used to assess whether the in-person RAVE-O intervention was successfully adapted to an online reading intervention. The implementation fidelity data showed that most RAVE-O components from the original lessons were fully included in the online lessons and adherence to the script in each lesson was sufficient. The principles of intensive intervention were adhered to while adapting the in-person intervention to a synchronous online intervention (Fuchs, Fuchs & Malone, 2017). The strength and dosage of the RAVE-O intervention translated well to the online environment, and implementing the lessons synchronously gave the students many opportunities to respond and be actively engaged during the sessions. The multifaceted components of the RAVE-O intervention ensured that the alignment of the intervention was excellent and that the lessons could be properly individualized. This occurred when Sophie showed limited progress on the WRF progress monitoring measure, so the decision was made to adjust the intervention sessions to better meet Sophie's needs, as is best practice in an RTI model. Following the suggestions Fuchs and Fuchs (2006) made, session length was increased slightly and more repetition was incorporated in the lessons. Sophie seemed to be struggling most with her phonological awareness and her fluency skills, so more emphasis was put on identifying the sounds in the *core words* and on the *RAN chart* activity, which was implemented to improve the speed and automaticity with which words were read. Since Sophie was already receiving the online intervention in a one-on-one format, group size could not be further reduced to intensify the intervention. The dosage of the program was held constant, as the RAVE-O intervention already offered the students many opportunities to respond and be actively engaged. The main strength of the RAVE-O program was in its multifaceted approach to reading, which allowed the researcher to address Sophie's specific areas of need with activities already included in a 'normal' RAVE-O lesson (i.e., the blending and rhyming of words and the RAN charts). These changes had a

positive effect on Sophie's reading skills, as improvements in decoding accuracy and fluency, in word reading accuracy, and in reading comprehension were found at post-test for Sophie.

Similarly to the synchronous online mathematics intervention implemented by Chappell and colleagues (2015), the online RAVE-O intervention included teacher modelling, guided practice, and active engagement. Student progress was monitored through several word reading, oral reading and comprehension measures and informed differentiation of the intervention lessons to ensure that the participants received an intervention that was tailored to their individual needs. However, one thing that the RAVE-O intervention was lacking was behavioural support for the students. Many students with reading impairments may get frustrated with themselves or their teachers, because something that seems so simple for other students is so hard for them. On more than one occasion, the participants in this study were challenged in the RAVE-O lessons and got frustrated or upset when they were not able to read a word or complete an activity. If behavioural supports had been included in the intervention to help the students understand why they struggled and to encourage them to keep practicing, the RAVE-O intervention might have been even more effective in enhancing their reading skills as well as their self-confidence in reading.

Parental support was also instrumental to student success in this study, as was found in previous research of an asynchronously implemented reading intervention (e.g., Fitzgerald et al., 2012). The participants' parents ensured that their children stayed focused and performed on-task behaviour. They also assisted when technical issues occurred on the students' end that the researcher could not resolve. The parents never provided any answers for the students, instead they encouraged their children to come up with the answer themselves. The level of parental involvement necessary differed between the paired administration and the individual administration. When the synchronous online intervention was implemented individually, the researcher could devote all of their attention to the one student and ensure on-task behaviour.

With multiple students, however, this was more difficult for the researcher to accomplish and thus the level of parental involvement necessary increased. Parents needed to be present during the intervention sessions to monitor their child and encourage on-task behaviour. This investment of time should be weighed carefully against the benefits of small-group online implementation. It might be more prudent to implement online interventions individually, to ensure student engagement is high and learning opportunities are maximized, while the cost for parents is diminished.

Another aspect that should be considered when designing and implementing interventions in an online setting is the likability of the intervention. The participants in this study were asked what they liked and disliked about the online RAVE-O intervention at the end of each intervention session. None of the students disliked any part of the RAVE-O intervention, and often responded that they liked everything about the lessons. This speaks to the ecological validity of the implemented intervention. All students thought that they had become better readers over the course of the intervention and felt that the RAVE-O lessons had really helped them. The students' parents also conveyed that they saw a lot of growth in their children's reading skills and attributed this to the implemented intervention.

Thus, to answer the second research question, the RAVE-O reading fluency intervention was successfully adapted to a synchronous online reading intervention while maintaining its efficacy, although some components of the RAVE-O intervention were easier to implement in an online setting than other components. This was in part because of time constraints, but it was also more difficult to implement activities that required individual administration in an online environment when teaching a pair or small group of students. During in-person interventions, it is easier to take one student apart and instruct the other student(s) to complete a worksheet. In this scenario, the researcher does not have to leave the room and can continue to keep an eye on both

students. During an online intervention, it is more difficult to take one student apart, as the researcher or interventionist cannot create a physical separation between students or give instructions to only one student and not the other(s). In the present study, Mitchell and Emma were placed in Zoom breakout rooms so that the progress monitoring measures could be administered individually, but this meant that the researcher could not keep an eye on the student in the breakout room and ensure on-task behaviour. Other activities that were difficult to implement in an online environment required active participation from the students. For the RAVE-O blending activity, wooden letter-cubes that the students could slam together to create a word were used in the in-person intervention. In the online intervention, the researcher would instruct the students to use their fingers or hands to mimic the act of slamming letters or word-parts together to create words. However, the students were reluctant to copy the researcher's hand movements and did not vocalize the sounds or word-parts they were slamming together. Choral reading of the words on the *word wall* and of the *Minute Stories* was also impractical in an online environment due to the delay in audio. However, this problem was easily solved by asking the participants to take turns reading the words and stories. A laser-pointer was used to follow along as the students read the stories from their screens. This aspect was easier to accomplish in the online environment than in a physical environment, as one can imagine it would be harder for a teacher to point to the words a student is reading in the student's book, let alone in multiple books, in an in-person setting. Similar aspects of the online RAVE-O intervention were easy to implement. Activities that required students to look at the shared screen, such as the reading of the *Minute Stories* and the introduction of new *core words* and their *MIMs,* received a high implementation fidelity score because it was easy to direct the attention of the students to the relevant words or images with the laser-pointer, and all students saw the exact same thing on their screen. The physical RAVE-O materials, such as the *image cards* and the *Minute Stories,* were

made available online and could easily be included in the PowerPoint lessons. Thus, activities that required individual administration or active participation were more difficult to implement and activities that required students to look at certain images or words on the screen were easier to implement in an online intervention. These findings should be taken into account in future research and implementation of online interventions.

Limitations

In this exploratory study that utilized a single-subject research design, three participants with reading difficulties received an online reading intervention. The results showed small improvements in the decoding accuracy and reading comprehension skills of all students, but no improvements in word reading fluency were found. These results, however, are not generalizable to a larger population, because the three participants that were included in this study do not form a representative sample of all struggling readers in grades 2 and 3. It cannot be concluded that the implemented online RAVE-O intervention will have the same effect on other students.

A major limitation of the present study is the inclusion of two participants in French Immersion. The intended number of participants was four, so that two equal groups could be created. While ten children were signed up for the intervention in the first weeks of recruitment, only three children completed the RAVE-O intervention. Moreover, two of these children, Emma and Sophie, were enrolled in French Immersion classrooms. This means that their below-average reading skills in English could be explained by a lack of formal instruction in the English language and the unfamiliarity with the English orthography, rather than by an actual impairment in reading skills. Nevertheless, the two participants spoke English as their first language. Their phonological awareness and naming speed skills were not impacted by their enrolment in a French Immersion classroom, as these skills rely on spoken language fluency and not reading fluency. Emma showed a deficit in naming speed skills and Sophie showed severe deficits in her

phonological awareness and in her naming speed skills. These are early indicators of reading difficulties regardless of language and thus the inclusion of both girls in the online RAVE-O intervention was warranted. Furthermore, their delays in reading were not fully remediated by the implemented online intervention, which is not what one would expect if the reading difficulties were merely due to a lack of formal instruction. Emma and Sophie both benefitted as a result of their participation, showing improvements on their accurate word reading and decoding skills from pre- to post-test.

A third limitation is that, due to the small sample size, no significance testing could be done to examine whether the students' reading skills showed a significant improvement from pre- to post-test. The increase in decoding accuracy, word reading accuracy and reading comprehension scores from pre-test to post-test for the three students might not be big enough to have a significant effect. The difference in scores could be due to chance and not to the implemented intervention, or the scores could naturally be regressing to the mean. Another reason why the lack of significance testing is a limitation is that it cannot be concluded whether the observed improvement is attributable to the RAVE-O intervention or whether it was caused by the classroom education or additional school supports that the participants received at the same time as the RAVE-O intervention. However, the participants and their parents did attribute the observed gains in reading skills to the online RAVE-O intervention. Moreover, while the results cannot be tested for statistical significance, the improvements seen in reading skills from pre- to post-test can have educational significance. For example, Emma scored well below average on a measure of decoding fluency at pre-test, but at post-test she scored in the below average range on that same subtest. Similarly, Mitchell scored well below average on a measure of word reading accuracy at pre-test but at post-test his score was below average, showing an educationally significant increase in his word reading skills.

Furthermore, all aspects of the present study were carried out by same researcher, which could have led to biased results. The researcher administered the pre- and post-test measures, implemented the intervention, and completed the implementation fidelity checklist. Hence, at post-test the participants were familiar with the researcher, which could have biased the post-test results. To reduce this bias, another person could have administered the pre- and post-test measures to the students to ensure blinded testing. Similarly, another person could have attended some of the intervention sessions and completed the implementation fidelity checklist to assess the researcher's work. If a second rater had been used, an interrater reliability coefficient could have been calculated for the implementation fidelity checklists, which would have increased the reliability of the measurement and reduced potential bias.

The final limitations of the present study were inherent to its design as an online intervention. Because all interactions between the researcher and the students were through a computer screen, it was more difficult to attend to nonverbal cues for the researcher, but also for the students. To engage the students in the sessions, they were often asked to copy the researcher's hand movements when blending sounds or word parts together, but this activity did not translate well through the screen, due to the delay in video feed. It was also difficult to choral read the *Minute Stories* together (i.e., at the same time) with the students because of the delay in audio. Another difficulty unique to online lessons was in the use of the laser pointer and other Zoom Annotate functions. The researcher used the available options frequently during the lessons, which enhanced the lessons greatly. However, sometimes mistakes did occur that led to confusion among the students. On more than one occasion, the researcher forgot to delete text that was added to the slides with the Zoom Annotate function during the lesson before moving on to the next slide. The added text would then overlap with the text on the new slide and make it harder for the students to read. Additionally, the level of parental involvement was higher than

with in-person interventions: The parents had to invest more of their own time in the online intervention and had to monitor their children and prompt them to stay on task. However, no quantitative data was collected on the level of parental involvement that was required for the online intervention. This could be addressed or controlled in future research studies on online interventions.

Directions for Future Research

Some of the difficulties mentioned previously, such as the individual administration of the *RAN Chart,* could be avoided by implementing the online reading intervention in a one-on-one format, so that the researcher or interventionist can give the student their full attention and ensure on-task behaviour. This would also reduce the amount of parental supervision necessary. Another modification that should be considered is reducing the length of the individual intervention sessions. Each intervention session in the present study lasted on average 70 minutes, twice the intended length of the lessons. No lesson was shorter than 55 minutes, which created a great demand on students' cognitive capacities and attention span. Especially the sessions that included the administration of the progress monitoring measures at the end of the lesson took up a lot of the students' time, and their exhaustion was often noticeable. By decreasing the amount of activities included in each intervention session or by decreasing the number of new *core words* introduced in each lesson, session length can be reduced to avoid exhausting the participants. In the present study, some of the RAVE-O lessons were split up and given over two intervention sessions. This might be a feasible solution for future online interventions. Future research should examine whether shorter online intervention sessions lead to similar improvements in literacy skills, either when the amount of sessions is held constant (i.e., 15-17 half-hour sessions in 8 weeks) or when the amount of intervention is held constant (i.e., 30-34 half-hour sessions over 16 weeks).

Additionally, future research should focus on examining the effectiveness of different components of a multicomponent intervention such as the RAVE-O. In this study, the emphasis in the online lessons was on the phonological and vocabulary components of the intervention, while the activities aimed at increasing reading fluency were often excluded. This was reflected in the final results, as the students showed improvements in their decoding and reading comprehension skills but not in their reading fluency. If more attention had been given to the fluency component, a similar increase in fluency skills might have been observed. This can be addressed in future research that looks at the effectiveness of different components in (online) interventions.

Furthermore, naming speed skills should be investigated in future research to see whether reading interventions, or other types of intervention, can be effective in increasing naming speed skills in students that show a deficit in that area. Previous research has found mixed results and this study found that the online RAVE-O intervention was not effective in increasing the naming speed skills of the three participants. However, interventions that are specifically aimed at increasing naming speed skills might find different results.

Another direction for future research is to replicate this study on a larger scale. The present study has shown that an in-person reading intervention can successfully be adapted for synchronous online implementation in a single-case research design. The next step is to test the effectiveness of an online reading intervention in a randomized control trial, with struggling readers in grades 2 to 5 that are randomly assigned to a treatment or control group. A multiple-baseline design can be used so that the control group also receives the online reading intervention after the intervention and post-test assessments for the treatment group have been concluded.

Conclusion

In conclusion, the present study has shown that a synchronously implemented online reading intervention can be effective in increasing the reading skills of three students in grade 2 and 3 with reading deficits. This study extends the small pool of existing research on online interventions and shows promising results. To the researcher's knowledge, no other study has attempted to implement a synchronous online reading intervention for struggling readers in grade 2 and 3. The findings suggest that a synchronous online reading intervention can be effective in increasing struggling readers' accurate decoding and word reading skills as well as their comprehension skills. For students in remote areas and for students that do not have easy access to intervention resources, this could mean that they can still reap the benefits of a reading intervention through online synchronous intervention sessions.

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Appendix A

Implementation Fidelity Checklist

Lesson number: Date:

Session duration:

Which students were present and consented to participation? (use initials only):

Goals	0	1	2
Start with warming-up activity			
Introduce core words			
Discuss Many Interesting Meanings of each core word			
Sound out the core words and identify rhyming pattern			
Have students complete their worksheets			
Introduce Eye Spy words			
Repeated reading of Minute Story			
Complete RAN chart			
Conclude the session appropriately			
Adherence to verbatim script			
Answer student questions adequately			
Engage students in activities			

0 = goal was not achieved; 1 = goal was partially achieved; 2 = goal was fully achieved.

Did any technical errors or issues occur? Yes/No. If yes, specify:

Other comments:

One thing the student(s) liked:

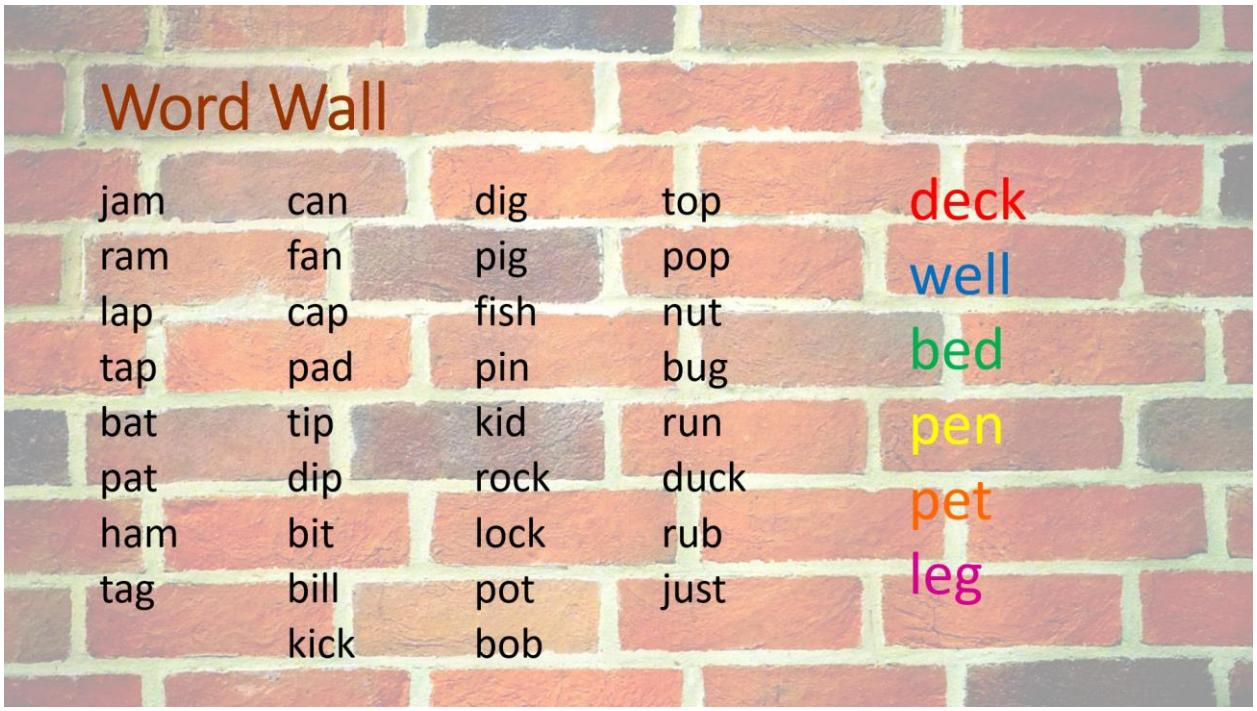
One thing the student(s) disliked:

Appendix B

Examples of PowerPoint slides from RAVE-O lesson 8.

Welcome slide:

Word Wall with lesson 8's *core words* in colour:



Slide with *Vowels* poster:

Vowels

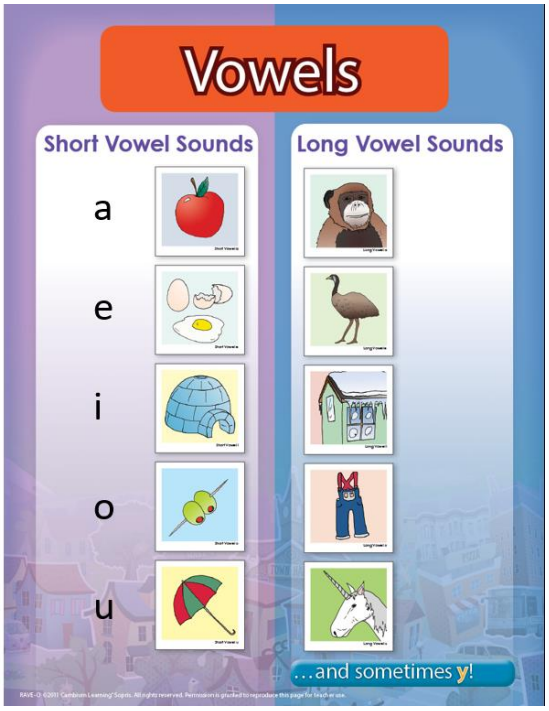
We're about to learn a whole new group of words.

deck well

Who can tell me what the new vowel is?

The new vowel is **e** and it makes the sound /e/ as in Emma's egg.

How many vowels do we know now?



Slide with *image cards* to explain the *MIMs* of *core word* 'well':

Slide with segmenting and blending activity:

bed

The first sound we hear is /b/. We write the sound /b/ with the letter b.

The next sound we hear is /e/. We write /e/ with the letter e.

The last sound we hear is /d/. We write /d/ with the letter d.

Let's blend the sounds together to make the word bed.

Slide with *Rhyme-Time tip* poster and *rime pattern* activity:

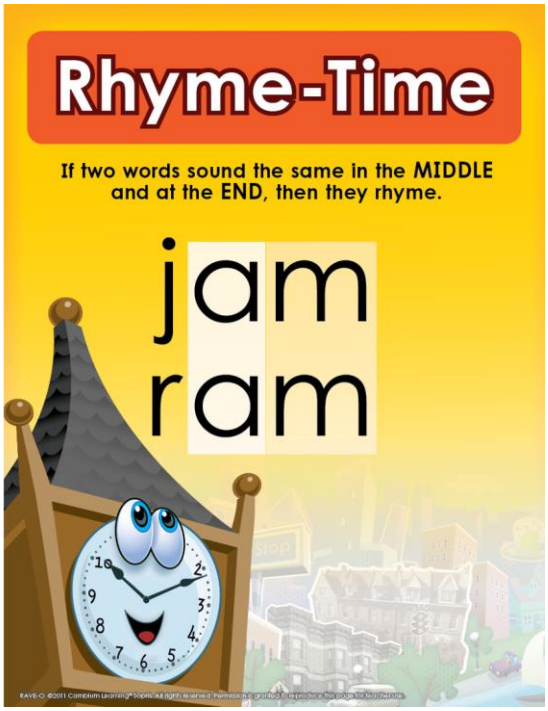
pet and set

pet

Was anyone able to hear the rime pattern in the word pet?

The new rime pattern in the word pet is '**et**'.

Tell me a word that rhymes with pet but begins with the letter s.



Slide with writing activity and screenshot of students' worksheet:

Now let's create leg

Trace the rime pattern **eg** in the first box.

Great! Now write the rime pattern even faster in the box below.

Can you add the /l/ sound to write the word leg?

Can you read the sentence?

Slide with lesson 8's *Eye Spy words*:

Eye Spy Words

is	she	of
has	his	he
the	at	we
a	it	him
and	I	up
in	are	
this	can-can	

then

very

water

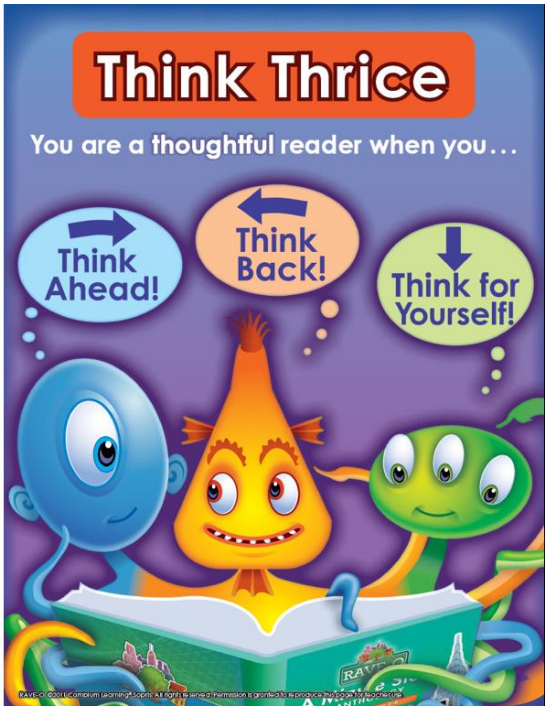
Slide with *Think Thrice* poster with comprehension strategies:

Think Thrice

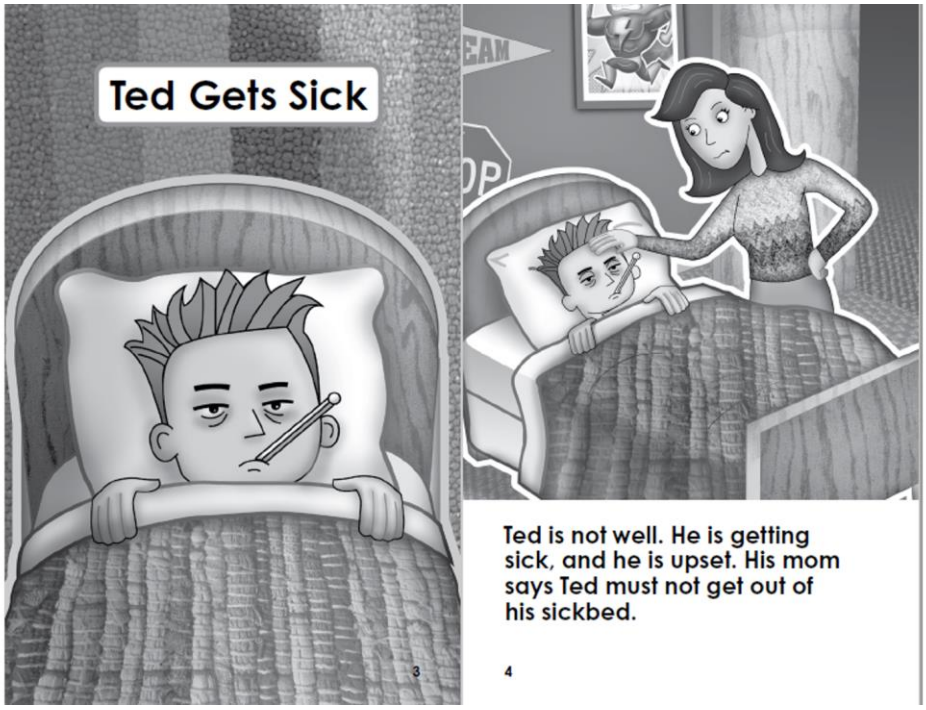
The title of our Minute Story is 'Ted Gets Sick'.

What might this story be about?

What questions should we keep in mind as we read this story?



Slide with the first page of lesson 8's *Minute Story* 'Ted Gets Sick':



Slide with the *RAN Chart* activity:

RAN Chart

Here is today's RAN Chart.

Remember, the most important thing is to read the words correctly.

UNIT 9

Name _____

RAN Chart (Core Words + Review)

can	kick	deck	pet
nut	well	lap	cap
bed	tap	pen	leg

Time taken:
1st reading _____ 2nd reading _____ 3rd reading _____

24

Final slide of lesson 8: