The Differential Effect of Print Consistency on Oral Vocabulary Learning in Bilingual Children

by

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Abstract

Research supports that the incidental exposure to print during oral vocabulary learning facilitates the acquisition of spoken words. However, it is not clear how this effect is moderated by print consistency. The current study examined whether different inconsistencies would moderate oral vocabulary learning when the children spoke more than one language. A paired-associate learning paradigm was used to teach French-English bilingual children (7 to 10 years old) novel labels for object referents. Children learned three types of non-words: non-words with a consistent-print, a final silent letter (common to French), and a double consonant in medial position (common to French and English). Unexpectedly, children learned consistent and double-consonant non-words more easily than silent-letter non-words. There were no differences between consistent and double-consonant non-words. This effect was maintained on expressive vocabulary one day later. However, children's spellings indicated the consistent non-words were easier to spell than both silent-letter and double-consonant non-words.

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Vocabulary knowledge is one of the central building blocks for efficient reading comprehension. For children in school, the goal of reading is comprehension, and comprehension itself depends in large part on their vocabulary (Cain & Oakhill, 2011; Rupley, 2005). The relation between reading and vocabulary, however, may be influenced by how many languages are known. That is, monolingual children who have stronger vocabulary knowledge usually have stronger reading comprehension skills (Ouellette, 2006). For bilingual children on the other hand, it is not as simple. Vocabulary knowledge in each language and its effects on reading depend on language proficiency and which language is being read (Bialystok, 2001). For instance, French-English bilingual children who have stronger French vocabulary skills may also have stronger French comprehension skills in comparison to English. Unfortunately, the vocabulary delay in English may lead to other academic difficulties if schooled in this language. As such, improving vocabulary acquisition for bilingual children is important in order to minimize the possible vocabulary lag between each language known and its effects on academic outcomes.

While vocabulary is necessary for comprehension, children also learn new words from reading (Swanborn & de Glopper, 1999). For example, children who read more and had higher reading comprehension skills in Grade 2 also had stronger vocabulary knowledge in Grades 5, 8 and 10 (Cain & Oakill, 2011). This suggests that reading for pleasure can provide children with opportunities to learn new vocabulary and that reading comprehension supports vocabulary development (Cain & Oakhill, 2011). Here, learning is *implicit* in that children are not aware that vocabulary learning is occurring during reading. However, to implicitly learn new words from context during reading and needing vocabulary to comprehend what is read, children must be able to process print. That is, children need to be able to read the printed words efficiently to understand the story and to also learn new words from books.

Print can also play a facilitative role during *oral* vocabulary acquisition. It is thought that print clarifies the pronunciations of words and facilitates the acquisition of sound representations (Ehri & Rosenthal, 2007). Indeed, recent studies showed that the incidental presence of printed words during learning facilitated the acquisition of spoken words in monolingual (Jubenville, Sénéchal, & Malette, 2014; Ricketts, Bishop, & Nation, 2009; Rosenthal & Ehri, 2008) and bilingual children (Jubenville et al., 2014). This facilitative effect of print, as compared to learning in the absence of print, has also been found in children with Autism (Lucas & Norbury, 2014), Down Syndrome (Mengoni, Nash, & Hulme, 2013) and speech language impairments (Ricketts, Dockrell, Patel, Charman, & Lindsay, 2015).

Although the facilitative effect of print is well established in monolingual children, less is known about such effects in children who speak more than one language. Specifically, differences in written language and its effects on oral vocabulary acquisition are not as well understood. For example, in Jubenville et al. (2014), bilingual children, in comparison to monolingual children, found it easier to learn from print when the words' spelling was inconsistent rather than consistent. This is surprising and warrants further examination. The current study examined the effects of written language differences on oral vocabulary acquisition in a bilingual sample. Specifically, this study focused on bilinguals who speak French and English and whenever possible, the research discussed examined these two languages.

The Lexicon and its Components

To have a vocabulary means to have knowledge of words. Words, put simply, are the smallest units in a language that have meaning and that can be moved around in an utterance (Clark, 1993). Furthermore, words by nature have *referents* in that they can refer to something that is either present or not present in time (e.g., the tooth fairy; Hoff, 2009). An individual's word knowledge is dimensional and can consist of different levels of representation such as semantics (meanings), phonology (sounds), orthography (spelling), pragmatics (knowing how and when to use words), syntax (grammar), and morphology (parts of words that contain meaning; Hu, 2003; Keiffer & Lesaux, 2012; Nash & Snowling, 2006). The primary focus of the current study was on the acquisition of novel phonological representations for novel referents.

Words and their different representations are stored in an individual's mental lexicon (Clark, 1993). For the purpose of the current study, it was assumed that the monolingual lexicon is composed of single entries for each word and its different levels of representation (Clark, 1993). In these entries, each level of representation is linked (Clark, 1993) or "amalgamated" (Ehri, 1978) to create one overall representation (this process is discussed in greater detail later).

For bilinguals, lexical organization is not as straightforward. It is often debated as to whether bilinguals store words in each language separately or together in the same lexicon. From the separate lexicon view, bilinguals have two distinct entries of a word and its different levels of representation in each language. These distinct entries are stored in separate lexicons (e.g., English *book* and French *livre*; Larsen, Fritsch, & Grava, 1994). It has been suggested that this can be a result of learning and using two languages exclusively in different settings (de Groot, 1993). For example, an individual who speaks only English at home, and only French at school may have two separate lexicons that contain words learned in each environment. More so, this explanation suggests that the meanings are language specific, that is, meanings associated with each language may be different.

Lexical organization is often examined by determining which languages are activated and accessed during speaking or reading. If bilinguals have separate lexicons, then they are thought to have language selective access and that only the target language is activated (Dijkstra, 2005). For instance, when exposed to the word *book*, French-English bilinguals with a language selective access do not activate its French equivalent *livre*. Early studies examining lexical access during reading in adult bilinguals have supported this view (De Groot, Delmaar, & Lupker, 2000, Experiment 2; Dijkstra, Van Jaarsveld, & Ten Brinke, 1998, Experiment 1; Gerard & Scarborough, 1989). However, there is another body of research that supports the opposing view, a shared lexicon.

In a shared lexicon, bilinguals are thought to have one semantic representation for a word with two equal phonological representations (one for each language; Larsen et al., 1994). This means that at the semantic level, the representations are combined, but at the phonological level, the representations are independent. For example, a French-English bilingual whose first language is French, has one semantic representation for *maison* but two phonological representations, French *maison* and English *house*. Because the semantic representations are stored in the same place, the lexicon for these bilinguals is unified (i.e., there is only one lexicon; Larsen et al., 1994).

Bilinguals with a shared lexicon have a language nonselective access during speaking or reading, that is, both languages are activated and accessed (Dijkstra, 2005). For instance, when exposed to the word *house*, French-English bilinguals activate both *maison* and *house*. Studies examining lexical access during reading in adult bilinguals have also supported this view (Brysbaert, Van Dyck, & Van de Poel, 1999; Jared & Kroll, 2001; Jared & Szucs, 2002; Lemhofer & Dijkstra, 2004; Nas, 1983).

Although older models suggested that lexical organization was binary, that is, either shared or separate, many do not take into account which level of representation (i.e., phonology, syntax, semantics, orthography) or process (i.e., speaking or reading) is being examined (Kroll & Tokowicz, 2005). Newer models of the bilingual lexicon are more flexible in that lexical organization is not binary. Some argue that the lexicon can be mixed in that entries can be shared or non-shared depending on level of representation or process (de Groot, 1995; Dong, Gui, & MacWhinney, 2005). For instance, when level of representation is taken into account, semantics can be shared or non-shared based on the word's lexical category. More concrete words (e.g., cat) are typically shared across languages as the meaning is the same in each language. However, more abstract words (e.g., happiness) can be non-shared across languages because their meanings are more subjective and can differ according to language (Kroll & Tokowitz, 2005). Therefore, depending on the type of words learned by bilingual adults, the entries may or may not be shared across the languages known.

Despite the popular interest in lexical organization, most of these studies have been done with bilingual adults and not children. One exception is the study done by Jared, Cormier, Levy, and Wade-Wooley (2012) with bilingual children in Grade 3. Jared et al. were interested in the processes of word representations and recognition in children and if it differed from adults. English-French bilingual children were asked to name English or French words that shared orthography and semantics (cognates e.g., *restaurant* in English and French), shared orthography but differed in semantics (interlingual homographs e.g., *pour* in English and French), and shared phonology but differed in orthography and semantics (homophones e.g., *show* in English and *chaud* in French). In French, bilingual children made more errors when naming homographs in comparison to control words, but made fewer errors when naming cognates and homophones. In English, bilingual children made more errors when naming homographs in comparison to control words, but there was no effect for cognates and homophones. This suggests that during reading, bilingual children activate each language's phonology, proposing a shared mental lexicon for children.

In summary, the monolingual lexicon contains a single entry for each word and its different levels of representation. The organization of the bilingual lexicon, on the other hand, may depend on different factors such as level of representation or process. Although these models are not tested in the current research, it highlights the importance that bilinguals can store words differently not only in comparison to other bilinguals, but also in comparison to monolinguals. The differences in lexical organization may be the reason that bilinguals fall behind their monolingual peers in terms of vocabulary (this is further discussed in a later section). The vocabulary lag in bilingual children warrants the attention of research examining vocabulary learning and how it can be facilitated.

Oral Vocabulary Acquisition

Learning new words occurs gradually as phonological and semantic representations are built in memory (Hoff, 2009) and can be retrieved (Rosenthal & Ehri, 2008). Oral vocabulary acquisition requires that hearing-individuals segment the stream of speech into words. Once individuals have acquired a phonological representation, they must then map it onto a meaning, if one exists. The word is then encoded and stored into long-term memory. Once the item is stored, hearing a familiar word then activates lexical access. Specifically, there is an automatic search of phonological representations in memory and the corresponding phonological form with its associated meaning is retrieved (Jahandarie, 1999). This ability to recognize and understand words is also known as *receptive vocabulary*.

The ease with which a word can be retrieved is influenced by the word's overall quality (Perfetti & Hart, 2002). Originally, the lexical quality hypothesis proposed by Perfetti and Hart (2002) indicated that a word has a high quality if a semantic representation is mapped to a phonological representation. Therefore, a word that has a phonological but no semantic representation, or vice versa, has a low quality, making it more difficult to be retrieved. For example, having a phonological representation for *car* but not having mapped it to its semantic representation would be considered low quality.

In addition to quality, long-term storage and retrieval of receptive vocabulary depends on word length and sound familiarity (Morra & Camba, 2009). Words that are shorter or that contain legal sounds in its respective language are easier to remember than longer words or words that contain sounds that do not exist (Morra & Camba, 2009). Furthermore, the more exposure that one has to words, the easier it might be to and retrieve such words (Gamez & Levine, 2013). Lastly, the way words are learned (e.g., learning strategies such as repetition and chunking) may influence long-term storage and retrieval.

These factors can also influence e*xpressive vocabulary*, that is, the ability to recall and produce words. In addition to cognitive and motor limitations, other factors that influence expressive vocabulary include maternal education and maternal age. Mothers of lower socioeconomic status and of younger age are less likely to describe and explain events around them, potentially leading to decreased expressive vocabulary in children (Westerlund & Lagerberg, 2008). Gender differences may also be seen in expressive vocabulary abilities, where girls tend to outperform boys (Westerlund & Lagerberg, 2008). Furthermore, activities at home, such as increased questioning during shared book reading, may lead to increased expressive vocabulary (Sénéchal, 1997).

Despite these factors, acquiring expressive vocabulary is quick for typically developing children. The exact acquisition rate and number of words in children's expressive vocabulary, however, is debated. For instance, Clark (1993) argues that by the age of two, children are learning approximately 10 new words a day and have a vocabulary of 600 words. By the time they are 6 years old, they are learning approximately 8 words a day and know 14,000 words. Others argue that these expressive vocabulary numbers are smaller. For example, children at the end of elementary school know approximately 9,000 words and through the ages of 9 to 12, they learn approximately 2.4 (Biemiller & Slonim, 2001) to 5 words a day (Anglin, 1993). Nonetheless, the process is still quick.

Bilingual vocabulary acquisition, that is, the process of acquiring two languages, is similar in comparison to monolingual vocabulary acquisition (Meisel, 2002). For the current purposes, bilingual vocabulary acquisition was considered as learning two languages simultaneously from birth or very early on. As such, children acquiring two languages hear words in a stream of speech and have to store phonological representations into memory, eventually mapping it onto semantic representations. What is more debated however, is how early the two languages are differentiated, that is, how early children know that words belong to one language and not the other (Bosch & Sebastian-Galles, 2002). Research suggests that bilingual children are able to differentiate between their two languages very early (e.g., 4 months old in Bosch & Sebastian-Galles, 2001 and 5 days old in Byers-Heinlein, Burns & Werker, 2010 Study 2).

Despite some similarities in the acquisition of vocabulary between monolingual and bilingual children, the rate of acquisition for bilingual children is slower in comparison to that of monolingual children (Genessee & Nicoladis, 2006; Pearson, Fernandez & Oller, 1993). This is possibly due to the differing amounts of exposure that bilingual children have to each language. Consequently, some studies demonstrate that bilingual children have smaller expressive vocabulary sizes in each of the languages known in comparison to monolingual children of the same age (20 months in Pearson et al., 1993; 7 to 8 years old and 10 to 11 years old in Oller, Pearson & Cobo-Lewis, 2007). It is also suggested that their expressive vocabulary knowledge is distributed across their two languages, in that they know words in one language, but not the other. Typically, their combined vocabularies are greater than the single vocabulary of a monolingual child (Oller & Pearson, 2002). However, these "total vocabularies" do not take into consideration the overlap between languages and are therefore not as useful when describing the bilingual vocabulary.

To summarize, both monolingual and bilingual children attend to sounds similarly and are able to map phonology onto semantics. Furthermore, they face similar constraints during oral vocabulary learning such as word length, learning strategy and maternal education. Despite this similar development, bilingual children still tend to lag behind their monolingual counterparts in expressive vocabulary in each individual language. This may be due to the amount of exposure in each language. If the assumption is that bilingual children have less exposure to each language, and if exposure is a factor leading to vocabulary size, it is not surprising that bilingual children have smaller vocabularies in each of their languages. In addition to hearing languages around them, children are also exposed to another source of information once they begin reading, that is, the language's orthography. Because the current study examined oral vocabulary acquisition in a sample of young readers, it is of interest to examine how orthographic representations can be added to the lexicon.

Written Vocabulary Acquisition

Once children begin learning to read, the word's orthography becomes another source of word knowledge. To become fluent readers and to be able to store orthographic representations into memory, children must have knowledge of their language's writing system (Liberman, 1992). That is, children must know that a letter (grapheme) corresponds to a sound (phoneme). Children engage in multiple reading strategies where this is demonstrated and these are discussed next.

As children become familiar with their writing system, they can use this knowledge to read unfamiliar words by decoding words into phonemes and graphemes (Ehri, 2014). Children turn graphemes into phonemes and then automatically search for corresponding words in their lexicon. In addition to decoding, other reading strategies include prediction and using analogies (Ehri, 2014). Prediction involves using initial word letters and context to identify upcoming words (e.g., recognizing the word *elephant* because the beginning letters "el" are familiar and there is a picture of an elephant on the page). When using analogies, children can apply their phoneme-grapheme knowledge to larger pieces that reoccur in other words. This means that they can identify the spelling pattern of a known word in an unknown word (e.g., recognizing that ump in the unfamiliar word PLUMP is the same letter-string as found in the familiar word JUMP; Ehri, 2014). Through these reading strategies, children are able to use their knowledge of their writing system to read unfamiliar words.

Exposure to reading allows children to "self-teach" word-specific spellings (Share, 1995). That is, children have experience independently reading texts that contain unfamiliar words and as children decode these words multiple times, they gain an opportunity to learn the words' spellings. Through repeated exposure to unfamiliar words, the word's orthography is eventually added or "amalgamated" to other representations for existing words in the lexicon (Ehri, 1978). In other words, o*rthographic mapping* occurs when children connect graphemes to phonemes to unify the orthographic, phonological and semantic representations of a word. As such, learning to read allows children to map orthographic representations to existing phonological and semantic representations.

Encoding orthographic representations depends on the individual's knowledge of letter-sound correspondences. Both French and English have words that vary in *print consistency*, that is, whether or not the correspondences between graphemes and phonemes are one-to-one (Laurent & Martinot, 2009; Spencer & Hanley, 2003). This means that French and English have words that are not spelled as they are pronounced, or that provide irregularities (e.g., *haut* /oʊ/ in French and *high* /haɪ/ in English). Because these words do not follow specific grapheme-phoneme rules, the inconsistent parts of the words (e.g., /aɪ/ in *high*) must then be learned by memory (Treiman & Kessler, 2014).

Perfetti and Hart's lexical quality hypothesis (2002) was further developed to include orthographic representations. It states that words that contain one-to-one grapheme-phoneme correspondences are higher in quality and this creates a more coherent and reliable overall word representation. As a result, different levels of representation (e.g., phonology and semantics) are more easily accessed and likely to be accessed simultaneously. Orthographic encoding is then facilitated when the orthography maps directly onto phonology.

In addition to print consistency, there are other factors that influence how well children can decode and encode orthographic representations. Similar to encoding phonological information upon spoken word recognition, the processes and memory abilities depend on the length and familiarity of the printed words (Gathercole & Baddeley, 1993). That is, words that contain more letters or unfamiliar letter sequences increase memory demands, making it more difficult to encode orthographic representations.

For bilinguals, encoding orthographic representations can also be influenced by the similarities between languages being read. Although French and English differ in some aspects, as discussed later, they share similarities that can facilitate print processing and orthographic encoding. Most obviously, they share the same alphabetic script and contain print inconsistencies. French and English also share common word spelling units and contain letter doublets usually found in middle-word position as oppose to initial or final position (Pasquarella, Deacon, Chen, Commissaire, & Au-Yeung, 2014). These similarities may contribute to the positive cross-language transfer of print processing in beginning readers (Deacon, Wade-Wooley, & Kirby, 2009). That is, due to the similarities, bilinguals can use their knowledge in one language to help them process print in another language. Furthermore, they can employ similar reading strategies and facilitate the process of encoding orthographic representations. In other words, if children are reading in two languages that share similarities, orthographic encoding can be facilitated.

To summarize, children can acquire orthographic representations through reading exposure. However, print consistency, word length and frequency can influence how easily this is done. For bilinguals, orthographic encoding is also influenced by similarities between languages known. Nonetheless, orthography can provide another access route to the lexicon. Children see words printed and this causes activation of orthographic representations in memory until the corresponding word is activated along with its phonological and semantic representations. Because the current study was interested in oral vocabulary acquisition, it is important to discuss how literacy could affect oral word recognition.

Effects of Orthography on Speech Processing

As mentioned before, oral vocabulary is first learned by segmenting speech and encoding phonological representations. However, when reading is introduced, letter-sound knowledge is acquired and another aspect of word knowledge is gained: its orthography. It is important then to discuss how knowledge of letters and their corresponding sounds can influence the way spoken words are processed. In a number of different tasks, it has been shown that indeed, orthographic knowledge can influence speech perception. For instance, when asked to count the number of syllables in a word, literate fourth-grade children reported more syllables for a word with more letters, in comparison to a word with less letters, even though both words contained the same number of syllables (e.g., the word *pitch* reported to have more syllables than *rich*; Ehri & Wilce, 1980). Similarly, children decompose oral pronunciations of words into correct number of syllables if they know how to spell them. For instance, the word *interesting* was segmented into four syllables (in/ter/est/ing) when children in Grade 4 knew how to spell it correctly. When children did not know how to spell it, it was segmented into three syllables (in/tres/ting; Ehri, 1984). The influence of orthography can also be seen on rhyme judgement tasks with fourth-grade children. Children took longer to decide if two words rhymed if they were spelt differently (e.g., cone – own) than two words that were spelled similarly (e.g., thrown – own; Weber-Fox, Spencer, Cuadrado, & Smith, 2003).

Expectations about the listener's written language can also have an effect on how spoken language is processed. As mentioned before, correspondences between letters and sounds are easier to learn when a letter is pronounced only one way. If a word contains a letter that could be pronounced more than one way (or not pronounced at all), children have a harder time deleting these letters from words in comparison to letters with one pronunciation. For example, it is easier for children in Grade 4 to delete the /f/ sound from *raft*, than it is from *laughter* (Castles, Holmes, Neath, & Kinoshita, 2003). Similarly, in a French adult sample, adults responded more slowly to words that could have alternative spellings (e.g., the rime in the French word *plomb* can be legally spelt *om, on* and *ong*) than to words with one single spelling (e.g., the rime in *stage* can only be spelt one way like *rage* and *cage*; Pattamadilok, Morais, Ventura, & Kolinksy, 2007; Ziegler & Ferrand, 1998).

Together, these results suggest that children's knowledge of letter-sound relations can influence the way they perceive speech. That is, when information is known about letters and sounds, this information is activated upon presentation of phonology. Further, whole word-spelling expectations can influence how these words are perceived. If both orthography and phonology are activated during spoken word processing, it is then of interest to see how supplementing oral vocabulary with orthography can facilitate learning. In the current study, children learned oral vocabulary in the presence of print.

Effect of Print on Oral Vocabulary Acquisition

Paired-associate learning paradigms are often useful in examining how the *incidental* presence of print can facilitate oral vocabulary learning. In other words, this paradigm can be used to examine how print facilitates learning when no attention is drawn to it. In this paradigm, stimuli are paired together and learning occurs through repeated exposure (Chow, 2014). In the studies to be discussed, the effect of print on oral vocabulary learning is examined and it is usually oral words (or non-words) that are paired with referents in the form of text, images, definitions or a combination of these. Children participate in a sequence of learning trials that consist of repetition and production trials. In the repetition trials, children are exposed to these pairings and after hearing the referent's label, they are asked to repeat it. They are then asked to produce the label without first hearing it (production trials). The repetition and production trials are repeated until a certain criterion has been reached. Children are assessed on how many words are repeated and produced during the learning trials as well as post-test recall and/or recognition of the words.

Ehri and Wilce (1979) were amongst the first to examine the facilitative effect of print on oral vocabulary acquisition using the paired associate paradigm in four different studies. In Studies 1 and 2 (Grades 1 and 2, respectively), children learned the oral labels of non-words (consonant-vowel-consonant blend sounds such as *kip*) in four different conditions: "squiggle" referent only, single-letter referent only (e.g., "V"), or single-letter referent with either the correct or incorrect spelling of the non-word written below the referent. In these two studies, children who saw the correct spelling of the non-words learned them more quickly during the learning trials in comparison to children who did not see the spelling (i.e., only saw the letter referent). Furthermore, in conditions where print was not provided, children who had single-letter referents learned the non-words more quickly compared to children who had the symbol referents. This suggests a print facilitation effect on learning new words. To clarify, children used the letters or spellings as symbols to memorize and store the phonological representation (Ehri & Wilce, 1979). However, alternative explanations exist. For example, when exposed to the print, this may have lead children to repeat the word an additional time. It is also possible that a characteristic of the letter referent acted as a cue to remember the word (Ehri & Wilce, 1979).

To eliminate these explanations for the print facilitation effect found, Ehri and Wilce (1979) conducted two other experiments. Instead of single-letter referents or squiggles, numbers (i.e., 1, 2, 3 or 4) were used as referents to be associated with the non-words in four different conditions: a visual spelling was shown; the experimenter spelled out loud the non-word; the experimenter sounded out the non-word; or the child repeated the non-word one additional time. It should be noted that here, the dependent measure was number of non-words recalled on each trial during learning (whereas in the first two studies it was number of trials to criterion). Results indicated that children who had the visual spelling during learning had higher recall of the non-words during the learning trials in comparison to children who did not have the spelling, further supporting the print facilitation effect. Even more so, in a fourth and final study, children who imagined the spellings recalled more non-words during learning in comparison to children who rehearsed the non-words multiple times. In summary, the four studies conducted by Ehri and Wilce (1979) support the notion that the presence of print helps children remember the pronunciation of new words, and as a result learn new oral vocabulary.

More recently, Rosenthal and Ehri (2008) conducted two studies to examine the effect of print on children’s ability to learn the meaning and pronunciations of new words. Children in Grades 2 and 5 (studies 1 and 2 respectively) were presented rare nouns with simplified oral definitions, as well as picture referents. Although the presence of print was manipulated, the researchers did not bring the children's attention to the print. That is, the presence of print in their study was *incidental*. Vocabulary post-tests one day later revealed that children were able to recall significantly more words when exposed to print in comparison to no print during learning.

It should be noted that children were told they were going to be tested on the words, and therefore it was important to remember them. This could have acted as a motivation for children to learn the words. Despite this weakness, the children were not made aware of the print's presence by the experimenters, indicating the effect of print was strong even when it was incidental. Rosenthal and Ehri (2008) posit that when spellings of new words are seen, children are able to store phonological representations sooner in memory during learning in comparison to children who did not see the spelling, which is what occurred in their study. The print could have served to clarify any ambiguity during the learning process and allowed them to learn the non-words sooner.

Ricketts et al. (2009) were also interested in the incidental presence of print and its effect on oral vocabulary learning. Although similar in methodology, Ricketts et al. were interested in how print affected *novel* word acquisition. That is, the researchers created non-words to ensure that children did not have any experience or exposure to them. English monolingual children in Grade 3 learned new words either in the presence or absence of print. Children in this study were told that they were going to learn words that an alien uses on its planet. Consistent with previous findings in Rosenthal and Ehri (2008), children who had the print present during learning had better post-test recognition. However, these results must be interpreted with caution as the words created were not matched on the number of letters and phonemes (e.g., joig and knarb), there were only two words per condition and few learning trials (three repetition trials and three production trials). Despite these limitations, it supports the positive effect of print on oral vocabulary learning.

Jubenville et al. (2014) extended the research by Rosenthal and Ehri (2008) and Ricketts et al. (2009) by conducting two studies, one with monolingual French-speaking and one with French-English bilingual children in Grade 3. The researchers extended their study to bilingual children because bilingualism can have cognitive advantages that may lead to differences in learning new words. Unlike Ricketts et al. (2009), Jubenville and colleagues (2014) ensured that the non-words were matched on number of letters and syllables, there were more non-words to be learned in each condition and children had more learning trials to acquire the non-words. Children learned the non-words with the same pictures used in Ricketts et al., either in the presence or absence of print. A day immediately after the learning trials, children's vocabulary acquisition was measured using recall and recognitions tests. Although children exposed to print learned more non-words during learning in comparison to children not exposed to print, both monolingual and bilingual children performed at ceiling on post-test recognition. This means they were able to correctly select the image out of a possible four 1 day later, suggesting that sufficient exposure to phonology is all that is needed to strengthen the quality of the phonology-semantic mapping. In other words, recognition requires a sufficient, but not complete match between phonology heard and the phonological representation stored in memory. In contrast, there was an effect of print for post-test recall for both monolingual and bilingual children. That is, children who saw the print during learning had better recall in comparison to children who did not see print during learning. This suggests that print may have strengthened the quality of the phonological representation in order for the non-words to be recalled.

The facilitative effect of print on oral vocabulary learning has also been shown with English-language learners (Hu, 2008), children with Down Syndrome (Mengoni et al., 2013), Autism (Lucas & Norbury, 2014), and speech language impairments (Ricketts et al., 2015). Children in this body of studies were able to learn words more easily in the presence of print during the learning trials and on post-test recall. In light of the amalgamation theory (Ehri, 1978), when orthographic representations are acquired, they are amalgamated or "glued" with a phonological representation, creating one overall representation. Therefore, it is possible that providing print during oral vocabulary learning strengthened the overall word representation made by the children in these studies. Given that the facilitative effect of print on oral vocabulary acquisition is strong, researchers then assessed whether the consistency of the print would moderate such an effect. This question is examined next.

Effect of Print Consistency on Oral Vocabulary Acquisition

As discussed earlier, written languages can vary in print consistency. In other words, there is variability in the correspondences between graphemes and phonemes within languages. Furthermore, languages can also vary in the direction of consistency, namely, whether a phoneme maps onto one grapheme, or whether a grapheme maps onto a phoneme. *Feedforward consistency* refers to how consistent graphemes predict phonemes, indicating the probability that a grapheme is pronounced as a certain phoneme. Whereas, *feedback consistency* refers to how consistently phonemes predict graphemes, indicating the probability that a phoneme is represented by a particular grapheme (Ziegler, Jacobs, & Stone, 1996). In either direction, inconsistencies can cause difficulties in learning and employing one's language. Specifically, feedforward consistency can make it difficult to read words and feedback consistency can make it difficult to spell.

Most alphabetic orthographies (e.g., German, Spanish, Dutch and Italian) are considered to be "shallow" or transparent where correspondences between phonemes and graphemes are one-to-one. For example, in Italian, the phoneme /f/ can only be represented by the grapheme -f- (e.g., "freddo", the Italian word for cold) making it very easy to read words. In these types of languages, there are few irregular words (i.e., words that contain inconsistencies between phonemes and graphemes). However, there are some alphabetic orthographies, such as French and English, which are considered to be "deep" or opaque languages, where correspondences between phonemes and graphemes are not as consistent. For example, the phoneme /f/ in English can be represented by different graphemes such as -f-, -ff-, -ph- and -gh- (e.g., "graph").

Because children in the current study were French-English bilinguals, a focus was made on French and English inconsistencies. One particular difference between the languages is where the phoneme-to-grapheme inconsistencies occur. In French, a mismatch between phoneme and grapheme is the common silent letter, that is, a grapheme that is not pronounced (e.g., the final letter *s* in the French word for three "trois" is silent; Perry, Ziegler, & Zorzi, 2014). In English, however, most inconsistencies between phonemes and graphemes occur due to vowels. For instance, two lexical databases were used to compare the frequency of silent endings for all words with orthographic consonant-vowel-consonant endings in English (Children's Printed Word Database: Masterson, Stuart, Dixon, & Lovejoy, 2010) and in French (Silex: Gingras & Sénéchal, 2015; with words from Manulex-infra: Peereman, Lété,

& Sprenger-Charolles, 2007). They concluded that 60% of these words ended in silent letters, whereas this was only apparent in 2% of the cases in English.

Although French and English typically differ in where their inconsistencies occur, they also share a source of inconsistency. That is, both French and English have words that contain double consonants. In a similar comparison as above, double consonants in medial position were apparent in 22% and 20% of French and English words with two phonological syllables, respectively. It is important to examine the effects of print consistency on vocabulary learning, especially in a country where both official languages contain inconsistencies. More so, if the incidental presence of print during oral vocabulary learning facilitates acquisition because it clarifies the pronunciation heard, how would this effect be moderated when the printed words have an inconsistent phoneme-to-grapheme orthography?

There are few studies that used the paired learning paradigm to assess the effects of print consistency on oral vocabulary acquisition. Two studies in particular that manipulated feedback consistency (phoneme-to-grapheme) are described here. In Ricketts et al. (2009), children learned consistent words (e.g., bilp), inconsistent words that included a silent consonant (e.g., knarb) and inconsistent words that included a silent vowel (e.g., loog). Their results indicated that children learned more consistent words than inconsistent words during the learning trials, but there was no interaction between the presence of print and print consistency. Therefore, the results of Ricketts et al. (2009) are not conclusive. Further, the lack of an interaction may be due to a poor research design as mentioned in the above section: only two non-words were available for each print-present condition and children only had three production trials during learning.

Due to the limitations of the study by Ricketts et al. (2009), Jubenville and colleagues (2014) also examined the effects of print consistency on children's ability to learn oral vocabulary. Two studies were conducted, one with monolingual children and one with bilingual children. Jubenville et al. (2014) increased the number of items to be learned per condition, increased the number of learning trials, measured recall at post-test and included a 1-day delay between the learning trials and post-tests. Children in the consistent-print condition learned non-words with a final vowel (e.g., boncli) and children in the inconsistent-print condition learned non-words with a final silent consonant (e.g., boclid). There was an effect of print consistency for both monolingual and bilingual children. As expected, learning was facilitated when monolingual children learned consistent non-words in comparison to inconsistent non-words. However, the consistency effect for monolingual children was no longer significant on post-test, suggesting that there is no lasting effect on recall. Interestingly, the consistency effect for bilingual children was reversed: learning was facilitated when inconsistent non-words were learned in comparison to consistent non-words. The same pattern of results appeared for recall one day later. This suggests that print inconsistency may make it more difficult for monolinguals to acquire phonological representation, but may have a facilitative effect for bilinguals.

The reversed consistency pattern between monolingual and bilingual children was surprising and unexpected. One possible explanation is that because the silent letter is rarely an occurrence in other languages, bilingual children in the inconsistent condition allocated their attention differently than children in the other conditions. To be exact, when children are reading in one language, both the phonology and orthography of each language are activated (Jared et al., 2012). It is possible that upon automatic activation of orthographic representations in each language (Jared & Kroll, 2001; Jared et al. 2012), the bilingual children in Jubenville et al. (2014) relied more on the print when learning inconsistent non-words to resolve the mismatch between the French orthography and other orthographies known. Therefore, it is possible that if the words contained an inconsistency common to both French and English (e.g., double consonant in medial word position), the same effect would not have occurred. That is, the double consonants would not have required the same attentional resources because they are common to both French and English and would not be learned as easily as words that require more attention (i.e., words with a final silent letter).

Although the results in Jubenville et al. (2014) did not indicate that bilingual children learned more non-words than monolingual children overall, attention could have contributed to the reversed consistency effect nonetheless. That is, it could have contributed to bilingual children learning more non-words with a silent letter than non-words without a silent letter. More specifically, when there is greater representational complexity, more control and attention is required. Simpler things require less attention and less processing (Bialystok, 2001). If the silent letters cause the non-words to be more complex, it is possible that children are paying more attention in order to process it in comparison to the non-words without a silent letter.

Incidental Exposure to Print and Spelling

Thus far, it is has been demonstrated that through exposure, children acquire phonological representations and this is facilitated when children are exposed to the incidental presence of print and potentially moderated by print consistency. However, children not only acquire phonological representations, but they also acquire orthographic representations during this exposure. Studies examining the effect of print on oral vocabulary learning provide evidence that children implicitly acquire orthographic representations during learning. That is, children exposed to print during oral vocabulary learning were able to correctly spell the words learned more than children not exposed to print during learning. This provides evidence that children may have been reading the print and reading provided the children with opportunities to encode and store the orthography implicitly. In other words, children were not aware that they were learning orthographic representations (Jubenville et al., 2014; Ricketts et al., 2009; Rosenthal & Ehri, 2008).

In these studies, implicit learning of inconsistent spellings was also examined. That is, the researchers were interested to see if there was an effect of print consistency on children's ability to spell the non-words learned. Here also, there was an effect. In Ricketts et al. (2009), results indicated that consistent words were more accurately spelt than inconsistent words. Similarly, in Jubenville et al. (2014) spelling of the first and second syllable were assessed to see if the silent letter in the inconsistent condition made acquiring an orthographic representation more difficult. There was no difficulty spelling the first syllable amongst children who learned inconsistent and consistent words. As expected, differences were seen between the two conditions on the spelling of the second syllable. Monolingual and bilingual children in the print-consistent condition were able to accurately spell the second syllable. However, the silent letter in the print-inconsistent condition proved to be difficult for the children learning these words. Interestingly, 95% of the errors made by the monolingual children in the inconsistent-print condition were made on the silent letter (93% of errors in bilingual children). Of these errors, 51% of children omitted the silent letter (45% of bilingual children), whereas the other 49% substituted the correct silent letter for another silent letter (55% of bilingual children). This suggests that silent letters are more difficult to encode into long-term memory. Further, this suggests that orthographic representations are constructed as "frames" based on consistent graphemes, and inconsistent graphemes are not represented or represented by “spacers” (i.e., other legal letters), in support of the fuzzy representation model proposed by Sénéchal, Gingras and l’Heureux (2015). Based on these findings, a secondary outcome that was of interest to the current study was whether the moderating effect of print consistency during oral vocabulary learning affects children’s ability to store orthographic representations.

The Present Study

In learning to read, children must be able to process the print in front of them. Research has provided evidence that the incidental presence of print facilitates learning new oral vocabulary as well. This has been shown in multiple studies using a paired-associate learning paradigm with typically-developing monolingual children in French and English, bilinguals (Jubenville et al., 2014), second language learners (Hu, 2008) as well as children with Down Syndrome (Mengoni et al., 2013), Autism (Lucas & Norbury, 2014), and speech language impairments (Ricketts et al., 2015). In these studies, print facilitated the learning of new oral vocabulary.

The effect of print consistency on oral vocabulary learning has also been investigated using the same paradigm (Jubenville et al., 2014; Ricketts et al., 2009). The researchers were interested in how phoneme-to-grapheme consistency affects children’s ability to learn new words. The French language provides many inconsistencies by containing frequent silent letters and as such, Jubenville et al. examined this effect in French monolingual and French-English bilingual children. In Jubenville et al., the effect of print consistency brought unexpected results. Specifically, monolingual children in the consistent-print condition learned more non-words during the learning trials and on post-test in comparison to children in the inconsistent-print condition. The opposite was true for bilingual children; it was children in the inconsistent-print condition that learned more non-words in the learning trials, as well as on post-tests in comparison to children in the consistent-print condition. This finding is surprising and the contributing mechanisms are only speculative. For example, because the silent letter is most common to the French language, attentional resources may have helped bilingual children recognize and pay more attention to it and create a stronger representation in memory. Investigating this idea further in bilingual children learning vocabulary is important for two reasons: First, bilingual children are becoming more prevalent in the education system and second, bilingual children continue to lag in expressive vocabulary development in comparison to their monolingual counterparts.

One goal of this study was to replicate the bilingual reversed consistency results of Jubenville et al. (2014). It is important to understand if the results of the children learning inconsistent words are a true occurrence or if the results occurred simply by chance or due to sample characteristics. The sample of the current study consisted of French-English bilingual children in Grade 3. Children learned oral labels for novel referents with three types of non-words varying in consistency: one with a consistent print, one with a silent letter and one with a double consonant. To assess how well the children formed representations of the words one day later, three post-tests were administered to measure expressive vocabulary, receptive vocabulary and spelling.

The primary goal of the research was to examine the moderating effect of varying print consistency on oral vocabulary learning in bilingual children. More specifically, children were exposed to two different inconsistencies: one common only to French (i.e., silent-letter word-endings) and one common to French and English (i.e., double consonants in medial-word position). It was of interest to see if the reversed consistency effect in Jubenville et al. (2014) occurred because the source of inconsistency was rare to the children's second language or if it was due to inconsistency in general.

Together with the research, the current researcher hypothesized the following:

1. Children would learn more non-words with a silent-letter than non-words with a consistent print or double consonant. However, children would learn more non-words with consistent print than non-words with double-consonants.
2. The same pattern of results that occurred for learning would occur for recall: Children would learn more non-words with a silent-letter, followed by non-words with a consistent print, and then non-words with a double-consonant.
3. Children would spell non-words with consistent print better than the other two type of words.

Methods

Participants

French-English bilingual children in grades 2, 3 and 4 were recruited from one community centre in Ottawa, one school in Ottawa, and one school in Gatineau. In total, 86 consent and information letters were sent to parents of French-English bilingual children. Forty-seven children were included in the initial sample. However, due to attrition (n = 1), not understanding study instructions in French (n = 3), and not achieving at least 80% on the decoding tasks (n = 3) these children were excluded. Forty children were included in the final analyses. Children ranged in age from 7;0 years to 11;8 years (*M* = 9;3 years), with an equal amount of boys and girls. All but one parent reported their child's hearing and of those reported, all children were reported to have normal hearing. All parents reported whether their child had been followed by a speech pathologist and five children were reported to have seen a speech pathologist. However, these children were not outliers on any of the pre-test measures or outcome measures and therefore were kept in the analyses.

Parents reported their level of education (see Table 1). The majority of mothers reported having a university degree (78%), with the remainder having completed college (20%) or high school (2%). Similarly, the majority of fathers reported having a university degree (61%), with the remainder having completed college (23%) or high school (13%). Three percent of fathers did not complete high school. Parents were also asked to report languages spoken at home by their children. The majority of the sample spoke French and/or English at home (60%), 13% spoke English and another language, 5% French and another language, 13% another language, and 10% French, English and another language (See Table 2). Additional language characteristics are in Appendices H to J.

Table 1

Parent Demographic Information Represented in Percentages

	Mother	Father
Parent Education	(n = 40)	(n = 39)
Did not complete high school	0	3
High School diploma	2	13
College diploma	20	23
Bachelor's degree	53	33
Graduate or professional degree	25	28
Parent Occupation	(n = 35)	(n = 33)
Management	14	12
Administration/Office	29	9
Business/Finance	11	6
Computer/Mathematics	9	3
Health Care	17	12
Engineering	3	3
Science	0	3
Education	3	0
Lawyer	9	9
Service/Sales	6	6
Personal Care	0	6
Other	0	15

Table 2

Languages Spoken in the Home by Children Represented in Percentages

Language	
French	10
English	15
Arabic	12
Slovak	0
French and English	35
French and Arabic	3
French and Chinese	3
English and Arabic	10
English and Chinese	2
English and Spanish	0
English and Indonesian	0
French, English and Arabic	8
French, English and Lebanese	2

Design

Children learned three types of non-words: non-words with a consistent print, non-words with a final silent letter, and non-words with a double consonant in medial word position. Children learned two novel labels for unfamiliar objects for each type of non-word by viewing picture referents on an iPad. The children had the labels for each object written above the picture referents. In addition, they only heard the audio label of the object once every time they saw a picture. Non-words with consistent print were consistent with the pronunciation (e.g., the label *lanfo* pronounced as /lãfo/). In contrast, the print in the silent-letter and double-consonant non-words were inconsistent with the pronunciation (e.g., the label *lafop* pronounced as /lafo/ and *laffo* pronounced as /lafo/).

Learning Material

The six unfamiliar objects associated with picture referents that were used were those used by Jubenville and colleagues (2014). Similarly, unfamiliar objects were used because the researchers hoped that the children had never seen them before, as done in previous studies (Jubenville et al., 2014; Ricketts et al. 2009). The labels used in Jubenville et al. were modified to reflect the additional inconsistency in the current study (i.e., the double-consonant non-words), while retaining as many as the original label characteristics as possible (Refer to Appendix A for a complete list of word triplets and their respective picture referents).

First, overall non-word construction followed similar steps as Jubenville et al. (2014). That is, all labels were matched on numerous characteristics: number of letters, number of phonemes, number of syllables, and number of orthographic and phonographic neighbours. Number of phonological neighbours were also calculated but although words can be phonologically similar, they can be very orthographically different. Because words that look *and* sound like other words (i.e., phonographic neighbours) can facilitate adult reading aloud (Peereman & Content, 1997), they were deemed more important than phonological neighbours. Further, the new non-word triplets did not exist in French or English to eliminate them sounding like real words, as done in Jubenville et al. (2014). For word characteristics see Table 3.

Second, to create labels for the double-consonant non-words, letters that are doubled in both French and English were chosen: *d*, *f*, and *l*. The letters chosen to be doubled were also reflected after the vowel sound for both consistent and silent-letter non-words within the word triplet. For example, if *f* was doubled in the double-consonant non-word, *f* was also used as the letter following the vowel for non-words in the other two types of non-words (e.g., lanfo, lafop, laffo). The vowel sounds used in the double-consonant non-words were the same as those used in the silent-letter n-words.

Third, two pairs of vowel sounds remained the same from Jubenville et al. (2014) but one was changed due to causing experimental error in their study. That is, verification checks revealed that during learning, experimenters stopped the learning trials due to falsely thinking that 12 (17%) children reached criterion. However, these children mispronounced at least one label during one of the production trials and should have continued learning. The source of these errors was often due to two pairs of non-words (i.e., reuglo/reglot and teuvro/tevrop). Specifically, the graphemes /eu/ and /e/ caused difficulty for the children and due to the close pronunciation of these vowel sounds, experimenters did not hear differences. To avoid such errors in the current study, a different pair of vowel sounds was included in the new labels, /an/ and /a/.

Table 3

Characteristics for Constructed Non-words To-Be-Learned

Consistent				Silent Letter				Double Consonant			
O	ON	P	PN	O	ON	P	PN	O	ON	P	PN
nouli	0	nuli	0	nulid	0	nyli	0	nulli	0	nyli	0
gando	0	gãdo	0	gadot	1	gado	1	gaddo	0	gado	0
joula	3	ʒula	3	julap	0	ʒyla	0	julla	1	ʒyla	0
lanfo	1	lãfo	1	lafop	1	lafo	0	laffo	0	lago	0
ronfa	2	ʁɔ̃fa	0	rofat	0	ʁɔfa	0	roffa	0	ʁɔfa	0
vondi	0	vɔ̃di	0	vodit	0	vdli	0	voddi	0	vɔdi	0
M =	1		0.7	*M* =	0.3		0.2	*M* =	0.2		0

Note. O = orthography; P = phonology; ON = orthographic neighbours, PN = phonographic neighbours, calculated using Manulex-infra (Peereman et al., 2007).

Vocabulary Learning

During the learning cycles, children were presented picture referents of unfamiliar objects accompanied by pre-recorded audio labels using an iPad. One learning cycle consisted of a repetition and production trial. All sessions began with a repetition trial followed by a production trial. Children completed a minimum of six and a maximum of nine cycles. Children continued learning until three consecutive production trials were successfully completed (provided the minimum of six cycles were completed) or until the maximum of nine cycles were reached. At the end of the learning, the children were offered to play a short game on the iPad. This was done to engage the children's interest in hope they would return for the subsequent session.

Repetition trials. Children saw the picture of the unfamiliar object with print and heard the audio label. The children were exposed to the picture for five seconds and then the screen turned white; they were asked to wait until the screen turned white to repeat the label of the object. If it was correctly repeated, the children moved on to learning the next object. However, if there was an error in the repetition, the experimenter gave corrective feedback. That is, the children saw the object with the label's print and heard the audio label again. Whether or not the children said the label correctly the second time, the experimenter moved on to learning the next object. All six labels were learned this way.

Production trials. After the six objects were seen in the repetition trial, a black screen appeared as a notice to the experimenter that the type of trial was changing. The children were told the game was changing and were asked to tell the experimenter the label of the object that appeared on the iPad. The picture referents were not accompanied by an audio label. If they could not remember the label, they were told to try their best and all non-responses received feedback. Additionally, the children saw the object with the label's print and heard the audio label. At the end of the production trial, a black screen let the experimenter know that another repetition trial was going to begin.

Outcome Measures

Expressive vocabulary. Expressive vocabulary was measured by asking the children to recall the labels they learned during the learning session. The children were presented with cards containing black and white pictures of the unfamiliar objects in a randomized order, and were asked to say the label of the object.

Receptive vocabulary. Receptive vocabulary was measured by asking children to recognize the labels. Using an iPad, the children were shown four of the six pictures of the unfamiliar objects at a time. While viewing the pictures, the children heard an audio label of one of the objects and were asked to point to the object that was heard. This was done for all six objects in a randomized order.

Spelling. The children heard each novel label twice for a second time and they were asked to spell them. The children were asked to write the object's label on a piece of paper when they hear them spoken through the iPad. The audio-recordings of the objects' labels were heard in a randomized order.

Control Measures

Level of bilingualism. Children's level of bilingualism was measured using a translated and shortened version of the Language and Social Background Questionnaire (Appendix B; Luk & Bialystok, 2013) completed by one of the child's parent or guardian. This questionnaire asked questions on demographic information (e.g., highest level of education of mother or father), child's language experience, (e.g., Does child understand any language other than French?) and language use in the home (e.g., Language used in the home for reading).

Orthographic processing. To ensure that the children were able to discriminate between French and English spellings, orthographic processing was measured using a dictionary task (Jared, Cormier, Levy, & Wade-Woolley 2013).

Children were presented with 20 different non-words with legal English spellings, and 20 different non-words with legal French spellings (α = .72; see Appendix G). They were asked whether or not each word belonged in an English or French dictionary.

Reading level. Children's French decoding ability was assessed with items that came from a subtest of the French reading test *Batterie d'évaluation du langage écrit* (BELEC; Mousty, Leybaert, Alegria, Content, & Morais, 1995), as done in Jubenville et al. (2014). The BELEC is a set of tests aimed at children ages 7 to 12 and measures speech segmentation, reading and spelling levels in French. The children's decoding abilities were assessed by modifying words from the BELEC MIM subtest. The words were modified to include the same sound units (seven consonants, four vowels, and three vowel digraphs) as in the non-words to be learned in the study. In total, children were asked to decode 15 non-words (e.g., vorel; see Appendix D for the full list of words). Children were shown one at a time, three cue cards with five non-words in black font and were asked to read each one as best and as fast as they can.

Word reading in French and English was assessed using one-minute word reading tests. In French, the one-minute word reading test developed by Khomsi (1999) was used. This test included 105 French words ranging from one to three syllables, increasing in difficulty (see Appendix E). Children were asked to read words column by column. Children were given one minute to read as many as words as they can.

In English, the one-minute word reading test developed by The Transvaal Education Department (1987) was used. This test included 159 one-syllable English words arranged in a matrix, increasing in difficulty (see Appendix F). Children were asked to read words row by row. Children were given one minute to read as many as words as they can. It should be noted that the English one-minute word reading test appeared to be easier than the French one-minute reading test described above. That is, the English test only included one-syllable words, whereas in French the words contained up to three syllables, making the test more complex. However, because children were schooled in French (and speaking English at home), it was anticipated that a more complex French reading test would not cause any issues.

Executive functioning. Bilingual children's ability to learn language can be influenced by executive functioning due to having to attend to different languages (Kapa & Columbo, 2014). As a control, executive functioning was measured using a Stroop test. Children were exposed to three different tasks: a word-reading task, a colour-naming task, and an incongruent colour-naming task (see Appendix C). In the word-reading task, children were asked to read colour names in French, that is, *bleu* (blue), *jaune* (yellow), *rouge* (red), and *vert* (green), printed in black ink. In the colour-naming task, children were asked to name the colours of groups of asterisks that were printed in either blue, yellow, red or green. Lastly, in the incongruent colour-naming task, children named the colours of colour names printed in incongruent colours (e.g., the colour name "bleu" printed in red). Executive functioning was used particularly in the last task when children had to ignore the word but name the print colour.

Exploratory Measures

Learning strategies. To determine if children used different learning strategies, they were asked two questions: whether they thought the words were easy or hard to learn, and whether there was anything they did to learn the words better.

Procedure

The study took place over three sessions on three separate days. All sessions were conducted with one child at a time in a quiet area of the community centre or schools. All tests and learning cycles were scored by the experimenter as the sessions occurred. Experimenters did not continue testing if children refused participation or if children seemed uncomfortable. Children who participated received a sticker at the end of each session, whereas children in the class who did not participate received stickers at the end of the study. Children who participated also received the opportunity to play a short game on an iPad after the learning session.

Pre-test. The order of measures was fixed for all children: orthographic processing, word decoding, French word reading, English word reading, and executive control. The pre-tests took approximately 10 minutes to administer.

Learning. The learning cycles occurred on the second day of testing. The learning cycles did not depend on the pre-tests and therefore it was not important if there was a delay between the two days. The learning cycle took approximately 20-25 minutes to administer.

Post-test. The post-tests took place one day immediately following the learning cycles. The first activity measured expressive vocabulary. The children were asked to recall the labels of the objects. If the children did not respond after five seconds, the experimenter moved on to the next card. No feedback was provided in this activity.

The second activity tested receptive vocabulary. The children were told a different game was going to begin. They were asked to recognize the object from an array of four objects once the label was heard. Once again, no feedback was provided in this activity.

The third activity in this session tested the children's spelling. They were asked to spell the label to the best of their ability. The children heard each label twice and were asked to wait to write the spelling until they heard the label the second time. No feedback was provided.

Lastly, the children were asked the two learning strategy questions. If the children did not want to answer, testing ended. The post-tests took approximately 5-10 minutes to administer.

Results

Preliminary Analysis

A set of pre-tests were included to ensure that children were able to correctly identify French and English spellings, as well as read in French and English. Scores on the orthographic processing, decoding, and French and English reading tests were examined and the distribution of scores on these tests did not display any outliers (see Table 4 for descriptive statistics). Children were able to accurately identify 78% of English and French spellings in the orthographic processing task. Further, children were able to decode at least 80% of the words on the decoding task, as in Jubenville et al. (2014). They were also able to read approximately 61% and 53% of the French and English words on the one-minute reading tasks, respectively. Although the amount of words appears to be low on the one-minute word reading tasks, children were in fact reading slightly more English words than the age norms based on an English monolingual sample. According to these norms, children aged 9;3 years read approximately 72 words, whereas the current sample read 84.3 words. Age norms were not given for the French one-minute word test. However, because the French words were more difficult than the words on the English test, and the children read a similar proportion of words, it was assumed that they read at a normal or higher level than what was expected. As children were equivalent readers in both French and English, they were deemed an adequate bilingual sample to test the current study's hypotheses.

Executive functioning was included as an exploratory measure because past studies have found that this skill is typically heightened in bilinguals and it can possibly influence vocabulary learning. However, when it was included as a covariate in subsequent analyses, it did not alter the results and therefore was not included in analyses.

Table 4

Summary of Descriptive Statistics and Inter-item Reliability for Pre-test Measures

				Range	
Measure	*M*	SD	α	Potential	Actual
Orthographic Processing	31.15	4.56	0.72	0-40	23-36
French Word Decoding	14.00	1.04	-[a]	0-15	12-15
French Word Reading	64.98	20.29	0.98[b]	0-105	25-104
English Word Reading	84.30	27.14	0.98[c]	0-158	26-145
Executive Functioning	50.09	12.25	-[d]	-[d]	20.67-78.32

[a]Children performed at ceiling on the French Word Decoding test, and therefore inter-item reliability could not be calculated.
[b]11 items had zero variance and therefore inter-item reliability is calculated on 94 items.
[c]19 items had zero variance and therefore inter-item reliability is calculated on 139 items.
[d]Executive functioning was calculated using colour-naming and reading times. Children were allowed to take as long as they needed and therefore there are no minimum or maximum scores for this test. As such, potential range for this measure is not provided.

An examination of language use in the home as reported by parents indicated that there was linguistic variability in the sample. Sixty-eight percent of children spoke more than two languages and languages spoken amongst the children varied. In addition, an attempt was made to obtain a sample of 9-year-old children as in

Jubenville et al. (2014). However, this was not possible due to recruitment issues and therefore the sample included children aged 7- to 11-years-old. As such, language spoken in the home and age were used as covariates when it altered the results. It must be noted that typically covariates are used to adjust the means and/or to reduce the error term in order to increase statistical power (Keppel & Wickens, 2004). In this instance, the covariate did not adjust the means as children did not vary in age or language use within themselves (i.e., children were not tested across different times where their age or language use would change). Rather, the covariate was used to reduce the error term when it altered the analysis, as children across the study varied in age and language use.

Vocabulary Learning

During the learning cycles, children were asked to repeat and produce six labels for non-words during repetition and production trials. Children's performance during repetition and production trials were analyzed separately. To do so, an ANOVA with cycle (nine cycles) and word type (consistent, silent letter, and double consonant) as within factors was performed. The assumption of sphericity was violated and therefore the Greenhouse-Geiser correction was used for these analyses.

It was expected that children should not have had difficulty repeating the non-words during learning, and children's performance would be at ceiling. This was the case as shown in Figure 1. Despite being able to repeat all non-words, it was expected that variability in learning would be seen during production trials. Indeed, this occurred, as shown in Figure 2. Evidently, there was a main effect of cycle, as children learned more as the cycles went on, $F(4.83, 188.26) = 160.45$, $p < .001$, $\eta^2_p = .80$. However, there was no main effect of word type, $F(1.98, 77.37) = 2.11$, $p = .13$. Results showed a significant interaction between cycle and word type, F(8.73, 340.30) = 2.00, *p* = .04, η^2_p = .05. Follow-up polynomial contrasts were then examined separately for each word type. Significant linear trends were present for all word types (*p*s < .001), further supporting that learning increased as cycles progressed. A significant cubic trend for silent-letter non-words was found, *p* < .001, and significant fourth order trends for consistent and double-consonant non-words were found, *p*s = .001 and .002, respectively. Despite small variability in the first five cycles, children performed near or at ceiling at the fifth cycle and onwards. More so, the scores for each word type were out of a total of two, and therefore the differences in the beginning cycles were small (i.e., differences found correspond to fractions of a word). Consequently, the results must be interpreted with caution.

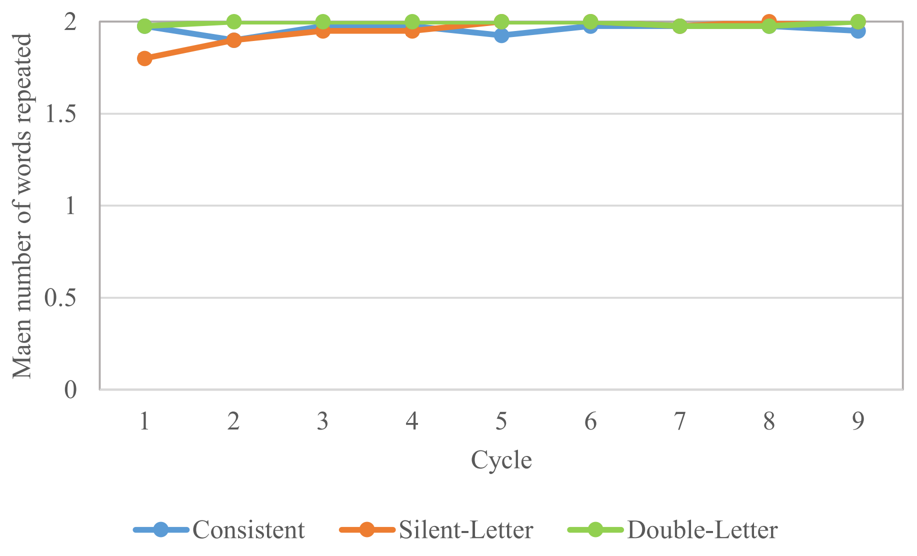

Figure 1. Children’s mean repetition scores for two words over nine cycles across different types of words. Error bars represent standard errors.

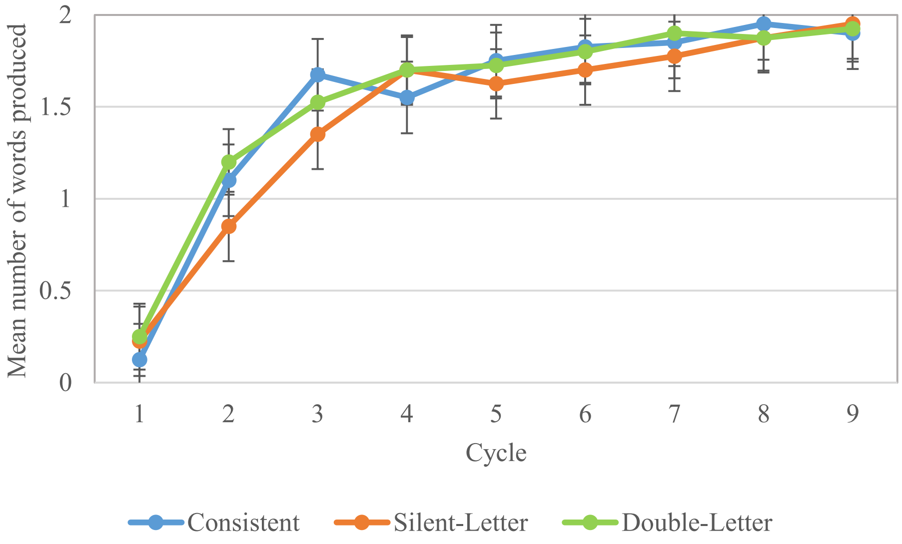

Figure 2. Children's mean production scores for two words over nine cycles across different types of words. Error bars represent standard errors.

Performance on Post-test

One day after learning, children were assessed on how well they remembered the non-words they learned the day before on three different measures: receptive vocabulary, expressive vocabulary, and spelling accuracy. Performance for these measures is shown in Table 5. An ANOVA with word type (consistent, silent and double consonant) as a within-subjects factor was conducted for each outcome. Here, sphericity was not violated and therefore no correction was used. It must be noted that for each measure, performance was skewed in that, on average, children's performance approached ceiling. Because of the limited variability in performance on post-test measures, true learning differences between word types might not have been detected. As such, the following analyses and results must be interpreted with caution.

For receptive vocabulary, children were asked to recognize the label of one of four objects presented to them. As shown by Table 5, children's performance on receptive vocabulary was at ceiling, as expected. Not surprisingly there was no main effect of word type, $F(1.63, 63.37) = 1.52$, $p = .23$.

Table 5

Children's Mean Performance (Standard Deviation) on Post-Tests across Word Type

	Word Type					
	Consistent		Silent Letter		Double Consonant	
Post-Test	M	SD	M	SD	M	SD
Receptive Vocabulary	1.98	0.16	2.00	0.00	1.95	0.22
Expressive Vocabulary	1.63	0.59	1.58	0.71	1.70	0.56
Spelling Accuracy	1.80	0.41	1.55	0.64	1.55	0.64

Note. Inter-item reliability was not calculated for post-test measures as children performed at near ceiling.

To examine whether learning differences were maintained on post-test, expressive vocabulary was measured. Here, children were asked to recall the label of each object. Despite children being able to recognize all non-words, it was expected that there would be differences on children's ability to recall them. With age and language spoken at home as covariates, there was a significant main effect of word type on expressive vocabulary performance, $F(2, 74) = 4.44$, $p = .02$, $\eta^2_p = .11$. To test the study's hypotheses, a pair of orthogonal planned comparison were examined. First, children's performance on silent-letter non-words was compared to that of consistent and double-consonant non-words, where it was expected that silent-letter non-words would be superior. The first comparison indicated a significant difference between silent-letter non-words and consistent and double-consonant non-words. However, contrary to expectations, children's performance on silent-letter words was poorer than the two other word types, $F(1, 37) = 5.63$, $p = .02$, η2p = .13. Second, children's performance on consistent non-words was compared to that of double-consonant non-words. Here, a stronger performance on consistent non-words than double-consonant words was expected. Yet, no significant difference between performance on consistent and double-consonant non-words was found, $F(1, 37) = 2.15$, $p = .15$. Children recalled approximately the same number of consistent and double-consonant non-words, again contrary to expectations.

To assess spelling accuracy of the non-words learned the day before, children heard the non-words twice and were asked to spell them. The main effect of word type approached significance, $F(2, 78) = 2.91$, $p = .06$. Because apriori hypotheses about the data were made, a pair of planned orthogonal contrasts were central to the analysis and were examined despite a non-significant main effect (Keppel & Wickins, 2004). First, children's performance on consistent words was compared to their performance on silent and double-consonant non-words. As expected, consistent non-words were spelled more accurately than silent-letter and double-consonant non-words, $F(1, 39) = 6.29$, $p = .02$, $\eta^2_p = .14$. The second contrast compared performance on the two inconsistent types of words. Here, no significant differences were found between performance on silent-letter and double-consonant non-words, as children's spelling accuracy was the same for both, $F(1, 39) = 1.00$.

Because both types of inconsistent words were spelled equally, it was of interest to see if the source of errors was due to the inconsistency, that is, the silent letter and double consonant. Specifically, it was interest to identify the types of errors made by the children. Of the errors made on the silent-letter non-words, 88% were made on the final-silent letter (remaining 12% included forgetting a vowel or adding a double consonant in addition to the correct silent letter). Of the errors made on the silent letter, the majority were omissions where children would not include the silent letter in their spellings (62%). The remaining 38% were substitutions where the spelling included a different silent letter (e.g., lafot instead of lafop). Of the errors made on the double-consonant non-words, 94% of these errors were made on the double consonant, while the remaining 6% included adding a silent letter in addition to the correct double-consonant. Of these double-consonant errors, the majority (76%) were omissions where children would only include one consonant (e.g., lafo instead of laffo). In addition, 18% of children omitted the double consonant and included a silent letter (e.g., lafot). The remaining 6% doubled an incorrect letter (e.g., vodii). The few errors on the consistent words included adding a silent letter (50%), adding a double consonant (38%) or other (12%).

Learning Strategies

As an exploratory measure, children were asked two questions: one, if they thought the words were easy or difficult to learn and two, if there was anything they did in particular to learn the words better. Almost half of the children thought it was easy to learn the words (45%), whereas 23% thought it was of medium difficulty, 25% thought it was difficult, and the remaining 23% expressed that it was difficult at the onset but became easier as the cycles went on. Of the children who indicated a learning strategy (80%), 40% used the print to learn the words (e.g., remembered the letters or associated the word's spellings with known spellings of other words), 28% repeated the words in their head, 19% used the pictures (e.g., associated the objects with objects they knew), and the remaining 13% used another strategy (e.g., created a song using the words).

In light of the different learning strategies used by the children, a preliminary examination of the means for expressive vocabulary was done to identify any possible advantage of one learning strategy over another. Statistical analyses were not conducted as some learning strategies were employed by too few children (e.g., only 4 children used pictures) and there would not have been enough power to detect true statistical differences. Nevertheless, the means indicated that children who used repetition had the highest recall of the non-words, overall, one day later. Whereas, children who used the pictures had the lowest recall. This pattern was also seen for consistent non-words only. For silent-letter non-words, children who used the pictures also had the lowest recall but had the highest recall when another strategy was used. In contrast, for double-consonant non-words, the lowest recall was when another strategy was used and the highest when no strategy was used. However, similarly to the other results, the differences are so minute that these results are only preliminary and must be interpreted with caution.

Table 6

Children's Mean Performance on Expressive Vocabulary across Word Type and Learning Strategy

Learning Strategy	Consistent	Silent Letter	Double Consonant	Total
Pictures (n = 4)	1.42	1.58	1.68	4.68
Words (n = 12)	1.56	1.61	1.69	4.87
Repetition (n = 7)	1.58	1.62	1.70	4.90
Other (n = 3)	1.54	1.66	1.66	4.88
No Strategy (n = 14)	1.55	1.63	1.71	4.89

Discussion

The main purpose of the current study was to examine the moderating effect of print consistency on oral vocabulary learning in light of previous findings. In previous research, monolingual children found it more difficult to learn words ending in silent letters than words with a consistent print (Jubenville et al., 2014). The reverse was true for bilingual children. Bilingual children found it easier to learn silent-letter words than consistent words. It was of interest to see if this effect could be replicated in another sample of bilingual children. To do so, words with a consistent print, words with a silent letter, and words with a double consonant were taught to children and various outcomes were measured to assess learning. Overall, the findings suggested a different learning pattern for different types of inconsistencies. Bilingual children had a better recall of consistent and double-consonant words than silent-letter words. However, no statistically significant difference was found between consistent and double-consonant words. Despite this, consistent words were more accurately spelled than silent-letter and double-consonant words. These findings along with their implications are discussed next.

Complexity of Print Inconsistency on Oral Vocabulary Learning

Past studies have shown that the presence of print during oral vocabulary learning can facilitate word learning in typically developing children in French and English monolinguals (Jubenville et al., 2014; Ricketts et al., 2009), bilinguals (Jubenville et al., 2014), second language learners (Hu, 2008) as well as children with Down Syndrome (Mengoni et al., 2013), Autism (Lucas & Norbury, 2014), and speech language impairments (Ricketts et al., 2015). If print facilitates oral vocabulary learning, it is not surprising that the ability to map phonology onto orthography is moderated by phoneme-grapheme consistency (Jubenville et al., 2014; Ricketts et al., 2009).

In the current study, learning was influenced by print consistency but it was not as expected. It was predicted that children's performance on silent-letter words would be superior to consistent words and double-consonant words, and consistent words would be superior to double-consonant words. However, the findings suggested a learning pattern similar to that of the monolingual children in Jubenville et al. (2014). That is, children in the current study learned consistent words more easily than silent-letter words. Surprisingly, there was no effect of the double-consonant. Children learned consistent words similarly as they did double-consonant words. The same consistency effect was retained on expressive vocabulary one day later.

The effect of the silent letter is discussed first, and an explanation for the lack of an effect of the double consonant follows. It is important to address Jubenville et al.'s (2014) explanation for why a reversed consistency effect was found for French-English bilinguals in their study. It was suggested that a reversed consistency effect was found because the silent letter in final-word position is typically not found in the English language (but is common in French). Upon seeing the words with a silent letter, there was a mismatch between the pronunciation heard and the pronunciation activated (i.e., in their mind, the silent letter was pronounced). This required more attention in order to resolve the mismatch, therefore heightening learning.

If the explanation for the reversed consistency effect found in Jubenville et al. (2014) is indeed true, it is possible that the same effect would have happened in the current sample. Although the current sample spoke French and English, as did the sample in Jubenville et al., approximately half of the sample also spoke Arabic. In Arabic, letters can be divided into sun and moon letters. When the determiner "al" ("the" in English) is preceded by a sun letter, the *l* becomes silent, whereas it is pronounced in front of moon letters (Saady, Ibrahim, & Eviatar, 2015). Other than this case of silent letters, all consonants are pronounced. In other words, silent letters in final-word position do not exist in Arabic. This means that in the current study, upon seeing the words with the silent letter, Arabic children could have activated a pronunciation, creating a mismatch between the pronunciation heard and the pronunciation activated. As Jubenville et al. suggested, this could have required more attention to resolve the mismatch in pronunciations and increased learning. However, this was not the case for the current sample. In fact, when children had knowledge of Arabic, their mean performance on silent-letter and consistent words was equal (M = 1.5 for silent-letter and consistent words, respectively), possibly suggesting that inconsistencies that are not common between languages do not facilitate vocabulary learning. However, because children were not strictly French-Arabic bilinguals, this is only speculative and does not taken into consideration the inter-play between multiple languages.

Some research on multilingualism (i.e., knowledge of more than two languages) suggests that like bilinguals, multilinguals have a shared lexicon for their languages known (Briellman et al., 2004). In Jubenville et al. (2014), only 17% of the sample was multilingual, whereas in the current sample, 68% were multilingual. There could be a hindering effect for vocabulary learning when more than two languages are activated. Specifically, when languages are linguistically different, the transfer of knowledge in one language might not help to process another language or processing is slowed (Deacon et al., 2009), which could have been the case for those who were dominant in their third language. In other words, for those who were dominant in a language other than French or English, using their knowledge of that language would not have helped to process the words to be learned in the current study. Although only preliminary, the comparison of means between those who were bilingual and those who were multilingual suggest that multilinguals in fact did perform slightly under bilinguals on expressive vocabulary post-test, but only for consistent and silent-letter words (Multilingual: M =1.59 and 1.51 for consistent and silent-letter words, respectively; Bilingual: M = 1.69 for consistent and silent-letter words, respectively). It must be noted that although only half of the sample spoke Arabic, the other half had some knowledge of a different language, some much different than French or English (e.g., Chinese). So although this explanation is speculative, it could apply to most of the sample. Nevertheless, it was parents that reported the majority of children having at least a moderate understanding of other languages known and knowledge of these languages was not actually measured. Future research using this paradigm would need to focus on specific languages (e.g., French and English only) or measure children's knowledge of other languages.

Now let us turn to the lack of an effect brought by the double-consonant words. An explanation for an effect of the silent-letter but not that of a double-consonant might be due to the complexity of the inconsistency. It is possible that it is not inconsistency in general that causes difficulty, but rather the complexity or direction of the inconsistency that renders learning more difficult. The current study focused on feedback consistency (phoneme-to-grapheme) but recall that there is another type, that is, feedforward consistency (grapheme-to-phoneme). In the current study, the final letter of the silent-letter words was feedforward inconsistent. That is, by adding a letter to the end of the labels, two things could have happened. The letter could have been pronounced, changing the words' pronunciation or it could have been silent, not changing the words' pronunciations. On the other hand, by adding a doubled consonant to the labels, the words' pronunciations were not changed (e.g., *lafo* and *laffo* are pronounced the same). In other words, the double-consonant words were feedforward consistent. Similarly in Ricketts et al. (2009), children learned the word "luss" which was considered to be a consistent word, but also learned the word "loog" which was considered to be an inconsistent word. Although both words contained a letter that was doubled, the word "loog" was considered to be inconsistent because the doubled *o* altered the pronunciation (i.e., *log* and *loog* have different pronunciations). On the other hand, adding an *s* to "lus" did not (i.e., *lus* and *luss* are pronounced the same). It is possible that because adding a doubled consonant to the labels in the current study did not change the pronunciation, there was not an effect of inconsistency. It is possible that these words were treated as consistent as in Ricketts et al. (2009), explaining why there were no differences found between the consistent and double-consonant words. Future studies could investigate this effect further by including more complex or feedforward inconsistencies to see any learning differences between them.

Alternatively, it is also possible that the lack of an effect between consistent and double-consonant words, as well as the reversed consistency effect, can be due to few items per word type and near ceiling effect during learning and on post-test. Children in the current study learned only two words per type in a within-subjects design, whereas in Jubenville et al. (2014), children learned six words in a between-subjects design. Too few items per word type could have been too little to detect any learning differences, as was the case in Ricketts et al. (2009) and could explain the near ceiling effect found during learning. More so, children were exposed to all three types of words, whereas in Jubenville et al., children learned one type of word. It is therefore possible that the lack of an effect was due to mixed exposure. That is, when words are not of only one type (e.g., silent-letter words only), the inconsistency is not as obvious. Children in Jubenville et al. could have noticed that all words had a final-silent letter. This observation could have led them to pay more attention to remember them. In the current study, children were exposed to three types of words and it is possible that inconsistencies were not as obvious, and therefore, no increased attention was paid to them. If children in the current study learned more words of each type or a between-subjects design was employed, as in Jubenville et al., a different outcome may have occurred.

Despite an effect of inconsistency provided by the silent letter during production and expressive vocabulary one day later, children were able to accurately repeat all words during learning, as well as recognize them one day later. This finding replicates past findings further suggesting that receptive vocabulary may not require a precise and accurate phonological overlap between what is heard and what is stored in memory (Jubenville et al., 2014). However, due to only having two items per word type, it is possible that there simply was not enough words to detect true learning differences. Future studies should include more words to avoid children reaching ceiling on post-test receptive vocabulary. More so, assessing children's receptive vocabulary of the words learned more than one day after could also assess if memory for words and different types of words are maintained over time.

Effect of Print Consistency on Spelling Acquisition

The current study replicated past findings that print consistency influences children's spelling accuracy (Jubenville et al., 2014; Ricketts et al., 2009). Children's spelling accuracy was better on consistent words than silent-letter and double-consonant words. This is in line with Perfetti and Hart's lexical quality hypothesis (2002) that states words containing one-to-one grapheme-phoneme correspondences are higher in quality and this creates a more coherent and reliable overall word representation. Therefore, the more predictable, or consistent, the spellings were, the easier it was for children to retain its orthographic representation.

Secondary analyses further identified that the locus of the errors in the silent-letter and double-consonant words was on the silent letter and double consonant. The majority of children omitted the silent letter or double consonant, suggesting that silent and double consonants are more difficult to encode into long-term memory. In accordance with the fuzzy representation model (Sénéchal et al., 2015), it can be thought that representations are constructed as "frames" based on consistent graphemes, and inconsistent graphemes are not represented or represented by "spacers" (i.e., other legal letters). Not only are the silent-letter errors comparable to what has been found in previous studies with French children (Sénéchal, 2000; Sénéchal, Basque & Leclaire, 2006), the current study extends this finding to double consonants as well.

Although children made fewer errors on the consistent words, the types of errors shed light on the difficulty that children learning opaque languages encounter during vocabulary learning. The majority of errors on consistent words were either the addition of a silent letter or double consonant, indicating that children's orthographic representations of the words learned were muddled. This difficulty is something that children most likely encounter on a daily basis as they are required to learn and know the different orthographic rules of their languages. This points to the advantage of providing orthography during oral vocabulary learning to help minimize these errors, as seen in Ricketts et al. (2009). This is in support of Share's self-teaching hypothesis, in that children acquire orthographic representations through the incidental exposure to print during oral vocabulary learning. Children's learning strategies during oral vocabulary learning also support the use of print during learning, where almost half the children who used a learning strategy stated they used the print to help them remember the words despite the print being incidental.

Limitations and Future Research

Several limitations of this study must be noted. Firstly, the results are limited by the ceiling effects found. That is, children, performed at near ceiling on the learning measures as well as the post-test outcomes. More so, the scores for each word type were out of a total of two, and therefore differences found correspond to fractions of a word. Consequently, the results are preliminary in making conclusions about the effect of print consistency on oral vocabulary learning in bilingual children.

Future studies need to include more words of each type of print consistency to detect any true learning differences.

Secondly, although the majority of the sample spoke two opaque languages, English and French, the majority of the sample also had knowledge of a third language. Linguistic differences between languages does not allow us to make conclusions about the effect of print consistency on oral vocabulary learning or generalize the results to specific languages. It is important that future studies investigate the effect of print consistency on oral vocabulary learning to children who speak the same languages.

Thirdly, the majority of children in the current sample also came from Montessori schools. Schools that follow a Montessori philosophy typically promote child independence and have a child-centred approach to teaching. Although the research on academic outcomes of children attending Montessori schools is not consistent, one study with preschool children suggests that the academic effects of Montessori schools depend on program fidelity (Lillard, 2002). Children who attended schools who highly implemented the Montessori program had better academic outcomes such as reading and vocabulary in comparison to children in conventional classrooms. No academic differences however were found between children in low-implementation Montessori programs and conventional classrooms (Lillard, 2012). Although it is unknown if the children from the current study came from high- or low-fidelity Montessori programs, it is possible that they performed better or differently than children in conventional school programs would have. Preliminary examination of mean performance on expressive vocabulary indicated that children in Montessori schools performed slightly below those not in Montessori schools. However, Montessori averages were similar to that of Arabic children so the interplay of languages known and its effect on learning may be masking any effect of attending a Montessori school. Nonetheless, the current study needs to be replicated with children from conventional schools.

Finally, this experimental design provided some insight into the difficulty or lack thereof, provided by inconsistencies. However, it did not ascertain whether the effect would be maintained over time. The current study was limited to testing children's recall and recognition of the learned labels one day after learning. Extending this delay to weeks or even months to investigate the long-term effects of print consistency is important. This would allow for a more naturalistic testing of children's vocabulary learning.

Overall, this study examined the moderating effect of print consistency on bilingual children's ability to learn novel labels. Findings from this study suggest that not all print inconsistencies during oral vocabulary learning render learning more difficult. Educational implications can be inferred from this research. For instance, teachers in schools or areas that have children speaking multiple languages of varying consistency can adjust their teaching of vocabulary and spelling to focus on print inconsistencies. It was shown that often, representations were muddled, especially in orthographic representations. By focusing on inconsistencies, children can develop clearer word representations.

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Appendix A

Words and their respective picture referents and labels.

Picture referent	Consistent Labels	Silent-Letter Labels	Double-Consonant Labels
	vondi	vodit	voddi
	gando	gadot	gaddo
	joula	julap	julla
	lanfo	lafop	laffo
	ronfa	rofat	roffa
	nouli	nulid	nulli

Appendix B

Language and Social Background Questionnaire

1. Today's date: ________________________________
day month year

2. Completed by: Mother ☐ Father ☐ Other ☐ (please specify)___________________

3. Your child's first name: _______________ Your child's last name: ____________

4. Your child's date of birth: _____________________ (Day/Month/Year)
5. Is your child female or male?______________
6. Is your child's hearing normal? YES _____ NO _______
7. Has your child ever received any speech therapy? YES _____ NO ______

Please indicate the highest level of education and occupation for each parent

MOTHER	FATHER
1.______No high school diploma	1.______No high school diploma
2.______High school graduate	2.______High school graduate
3.______Some college/college diploma	3.______Some college/college diploma
4.______Bachelor's degree	4.______Bachelor's degree
5.______Graduate or professional degree	5.______Graduate or professional degree
Occupation: __________	Occupation:__________

Does your child *understand* any language other than French?

yes ☐

no ☐

If **yes**, how would you rate your child's understanding of the other language(s)?

Name other language(s)	Poor	Fair	Moderate	Good	Excellent
__________________________________	☐	☐	☐	☐	☐
__________________________________	☐	☐	☐	☐	☐

Does your child *speak* any language other than French?

yes ☐

no ☐

If **yes**, how would you rate your child's speaking of the other language(s)?

Name other language(s)	Poor	Fair	Moderate	Good	Excellent
______________________	☐	☐	☐	☐	☐
______________________	☐	☐	☐	☐	☐

In which order did your child learn to speak each language? Please indicate if languages were learned at the same time.

First language spoken ____

Second language spoken ______________________________________

Third language spoken ____

Languages learned at the same time _____________________________

Which language does your child use to speak to:

	French only	English only	French and English	Other
Mother	☐	☐	☐	☐
Father	☐	☐	☐	☐
Siblings	☐	☐	☐	☐
Friends	☐	☐	☐	☐

Which language does your child use for:

	French only	English only	French and English	Other
Reading	☐	☐	☐	☐
Music	☐	☐	☐	☐
TV/Movies	☐	☐	☐	☐
Internet	☐	☐	☐	☐

Overall, which language does your child use most often in the home?

French only	English only	French and English	Other
☐	☐	☐	☐

Appendix C

Stroop Test.

ROUGE	BLEU	VERT	JAUNE
BLEU	JAUNE	ROUGE	VERT
VERT	ROUGE	JAUNE	BLEU
BLEU	ROUGE	JAUNE	VERT

******	*****	***	****
***	*****	****	******
****	******	*****	***
******	*****	***	****

ROUGE	BLEU	VERT	JAUNE
BLEU	JAUNE	ROUGE	VERT
VERT	ROUGE	JAUNE	BLEU
BLEU	ROUGE	JAUNE	VERT

Appendix D

BELEC word decoding

Training words
ami
film
escalier
livre
boulanger
Card 1
govla
vorel
posbu
clovra
glouvre
Card 2
deblou
tubli
blume
pifron
gouvla
Card 3
druval
joucra
tidron
jancra
francli

Appendix E

French one-minute word reading

il	**mars**	**naïf**	**éléphant**	**briller**
un	**jaune**	**curieux**	**trésor**	**guêpe**
le	**parc**	**venir**	**choc**	**feuillage**
lui	**sept**	**départ**	**fier**	**gymnastique**
nu	**bloc**	**écho**	**nouveau**	**fauteuil**
os	**faim**	**devient**	**expert**	**obtenir**
et	**compter**	**mardi**	**sportif**	**jusque**
fil	**poisson**	**drôle**	**merveilleux**	**expliquer**
bol	**herbe**	**histoire**	**odeur**	**magnifique**
tous	**pied**	**glacé**	**plongeant**	**spécial**
mur	**chemin**	**derrière**	**parent**	**fenouil**
sac	**joie**	**coloquinte**	**idéal**	**gourmand**
clé	**phare**	**stylo**	**obéir**	**chirurgien**
est	**ciel**	**magasin**	**griller**	**prévenir**
rue	**coup**	**cueillir**	**travail**	**assiette**
petit	**chorale**	**compagnon**	**yacht**	**dangereux**
camion	**bruit**	**chronomètre**	**animal**	**observer**
nom	**monsieur**	**continuent**	**surprise**	**obscurité**
acide	**agir**	**soleil**	**doigt**	**descendre**
film	**cousin**	**pharmacie**	**sommeil**	**installeront**
grand	**unir**	**enveloppe**	**réunir**	**inquiétude**

Appendix F

English one-minute word reading

Version 1

is	me	on	at	by	so	us	7
an	it	or	be	to	as	he	14
of	in	go	up	am	if	no	21
we	my	ox	do	the	and	for	28
but	him	are	can	she	dog	let	35
you	not	was	out	try	see	mix	42
cat	now	boy	saw	bit	met	top	49
run	man	pet	lot	get	dig	van	56
bad	red	cup	bee	lit	pin	had	63
ran	pen	nut	big	old	yet	rob	70
gun	leg	fun	lip	new	fog	has	77
sit	sly	wig	mud	box	ink	sat	84
end	cut	pay	fed	who	six	lad	91
met	dry	cow	his	peg	tin	say	98
eat	any	far	set	bud	kid	pup	105
fox	ask	egg	cab	ill	use	jam	112
all	pit	got	sad	tea	sky	one	119
yes	fur	act	toe	her	own	ten	126
arm	rock	gone	feel	that	rich		132
till	long	flat	this	part	foot		138
maid	upon	came	mile	back			143
sand	time	said	then	wall			148
into	were	done	walk	much			153
loss	seen	went	with	come			158

Appendix G

Dictionary Task

English items	**French items**
knoop	fonque
dray	rauffe
glawn	meuille
sheam	veurre
pleek	biette
blesh	toeud
weeth	pouche
jight	jouille
stike	veigne
hidge	jomme
lirst	minq
nitch	geuve
troak	dambe
morch	poeuf
spowd	kanche
thuck	niffe
crump	sotre
whurn	teul
yalk	roif
chash	dille

Appendix H

Table representing order of languages learned by children. Numbers represent percentages.

Languages	Learned in Order (First, Second, Third; n = 26)	Learned at the Same Time (n = 14)
French, English	8	57
English, French	15	0
English, Spanish	0	7
English, Arabic	7	0
French, Kirundi	7	0
French, Lebanese	0	7
French, English, Spanish	8	0
French, Arabic, English	4	14
English, French, Arabic	4	0
English, French, Chinese	4	0
English, French, Slovak	4	0
English, French, Persian	4	0
English, French, Italian	4	0
English, Arabic, French	4	0

Appendix I

Table representing children's ability to understand and speak different languages as rated by parents. Numbers represent percentages.

	Rating				
Understand:	Poor	Fair	Moderate	Good	Excellent
English (n = 40)	0	5	2	33	60
Arabic (n = 18)	6	0	33	22	39
Spanish (n =3)	0	0	66	34	0
Chinese (n = 2)	0	50	0	50	0
Slovak (n = 2)	0	100	0	0	0
Lebanese (n =1)	0	0	0	0	100
Kirundi (n =1)	0	0	100	0	0
Indonesian (n =1)	0	100	0	0	0
Persian (n =1)	0	0	100	0	0
Armenian (n = 1)	0	0	100	0	0
Speak:					
English (n = 37)	0	5	3	35	62
Arabic (n = 15)	0	20	27	33	20
Spanish (n =3)	0	0	66	34	0
Chinese (n = 2)	50	0	50	0	0
Slovak (n = 2)	0	100	0	0	0
Lebanese (n =1)	0	0	0	100	0
Kirundi (n =1)	0	100	0	0	0
Indonesian (n =1)	0	100	0	0	0
Armenian (n = 1)	0	0	100	0	0

Appendix J

Table representing children's use of different languages for different activities at home. Numbers represent percentages.

Language	Speak to Mother	Speak to Father	Speak to Siblings (n = 35)	Speak to Friends	Reading	Music	TV (n = 39)	Internet (n = 37)
French	10	15	21	10	20	20	3	8
English	23	13	23	5	3	25	46	51
Arabic	15	18	8	0	0	0	0	0
Slovak	3	3	0	0	0	0	0	0
French and English	25	28	37	75	70	38	49	38
French and Arabic	3	3	0	0	0	0	0	0
French and Chinese	3	3	3	3	3	0	0	0
English and Arabic	8	8	3	3	0	10	0	0
English and Chinese	0	0	0	0	0	0	0	0
English and Spanish	3	3	0	0	0	0	0	0
English and Indonesian	3	0	0	0	0	0	0	0
French, English and Arabic	5	8	8	5	3	3	3	3
French, English and Lebanese	3	3	0	0	3	0	0	0

Note. Unless otherwise specified, percentages are based on a sample of 40.