How do Children Process Words in Stories?

Differential Semantic and Perceptual Processing of Words Read in Context and Isolation

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ABSTRACT

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Many researchers have endeavoured to clarify whether children are more successful when learning words in context or in isolation. However, the cognitive processes elicited during contextual and isolated-word reading have yet to be examined in children. The current study investigated whether semantic and perceptual processes are differentially activated when words are read in context and isolation. Twenty-two younger children (7 – 9 years old), 21 older children (11 – 13 years old), and 24 undergraduates (18 – 35 years old) were exposed to a total of 20 target words: 10 words were read in a story (context) and 10 different words were read in a list (isolation). Participants then completed a surprise explicit recall task as a gauge of semantic processing and an implicit word stem-completion task as a gauge of perceptual processing. Words read in isolation were both explicitly recalled *and* used on the implicit word-stem task to a greater extent than words read in context. The results are discussed in terms of their relation to semantic and perceptual processes.

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When a child names a word correctly in print, it opens the door for many positive outcomes such as bolstering academic self-perception (Tunmer & Chapman, 2002) and increasing literacy competence (Bus & van IJzendoorn, 1999). Therefore, providing opportunities that increase the likelihood of early reading success is crucial in developing literacy-related skills. Successful word-reading increases the likelihood that a child will amalgamate a word's sounds (phonology) with its correct letter string (orthography) (Share, 1995, 1999). In turn, these essential elements are internalized as lexical representations, which support the development of increasingly sophisticated word recognition skills. Given the importance of providing children with positive reading experiences, many researchers have attempted to identify the most fruitful methods of reading instruction. To this end, a debate has emerged over the benefits of reading words in context (e.g., stories) versus reading words in isolation (e.g., lists; Martin-Chang & Levy, 2005). Indeed, differences in reading performance have been found between contextual and isolated-word reading, and it is hypothesized that these differences may stem from different cognitive processes engaged in the readers (Martin-Chang, Levy, O'Neil, 2007). Previous research with undergraduate students has supported this hypothesis (Martin-Chang, Levesque, & Ladd, 2010); however, the processes elicited by stories and lists remain somewhat unclear with regards to younger readers. As such, the current study investigated the cognitive processes – specifically semantic and perceptual processing – elicited by children during contextual and isolated-word reading.

Literature Review

Learning to read is arguably the most important academic milestone in a young child's life (Carroll & Snowling, 2004; Cunningham & Stanovich, 1997; Sénéchal, Pagan, Lever, & Ouellette, 2008). Successful reading acquisition is one of the primary contributing factors to future reading ability and academic success (Cunningham & Stanovich, 1997). In fact, children's reading experience is independently predictive of a myriad of cognitive abilities such as vocabulary breadth, verbal proficiency, reading speed and comprehension, spelling, and general knowledge (Cunningham & Stanovich, 1997; Martin-Chang & Gould, 2008; Sénéchal, Pagan, Lever, & Ouellette, 2008; Stanovich & Cunningham, 1993; Stanovich, West, & Cunningham, 1995).

Undoubtedly, the acquisition of skilled reading is a complex endeavour. It is generally accepted that the first steps towards successful literacy acquisition lie in a solid foundation of phonological awareness (the awareness and access to sounds in spoken language; Adams, 1990; Bruck, 1990; Bus & van IJzendoorn, 1999; Nation & Snowling, 1998), and alphabetic knowledge (Aram, 2006; Aram & Biron, 2004; Justice & Ezell, 2002). Following the acquisition of these pre-literacy skills, and with essential literacy instruction provided by skilled educators, parents, and caregivers, children begin the practice of reading words on their own.

Naming words in print requires children to access and utilize multiple sources of information in order to arrive at their correct pronunciation. Fluent reading – reading with accuracy, speed, and comprehension – is made possible as children develop increasingly sophisticated phonological awareness (Adams, 1990; Wagner & Torgensen, 1987) and orthographic knowledge (the learning of letter-sound correspondences and letter regularities in print; Roman, Kirby, Parrila, Wade-Woolley, & Deacon, 2009). Empirical data overwhelmingly support the role of phonological and orthographic processing in the development of children's reading skills (Badian, 1994; Bus & van IJzendoorn, 1999; Cunningham & Stanovich, 1990; Roman et al., 2009). Phonology and orthography figure prominently in models of reading development such as the *lexical quality hypothesis*. Specifically, the lexical quality hypothesis postulates that reading developments transpire as a result of the amalgamation of phonological, orthographic, and semantic information in memory (Perfetti, 2007; Perfetti & Hart, 2002). The fusion of letter-sound information for any specific word is hypothesized to form a unique lexical representation that helps guide the reading of those words during future encounters (Bowey & Muller, 2005; Share, 1995, 1999). That is, as children become increasingly familiar with the sounds and letter structures of words, reading becomes less effortful and more automatic, which allows for greater reading fluency (Ehri, 1999).

Lexical representations are formed gradually over time through one's exposure to the spoken and written forms of a particular language. They represent the culmination of acquired knowledge and experience with a word's sounds, spelling, and meaning. Furthermore, it is argued that the creation of high quality lexical representations is essential for fluent reading (Nation & Cocksey, 2009b; Perfetti, 2007; Perfetti & Hart, 2002). While the discussion on lexical representation can be somewhat theoretical, what is important to understand is that developing readers require many successful reading experiences in order for them to internalize the correct phonological and orthographic information of words. For instance, in order to form an accurate lexical representation of the word *banana*, that word must first be read correctly and consistently over multiple exposures in print. This allows for the word's orthographic letter configuration ("banana") to be paired with its sounds (/b/ /ə/ /n/ /æ/ /n/ /ə/) and basic meaning (a fruit), which may or may not have been previously internalized. It is therefore imperative that children are exposed to literacy experiences that increase the likelihood that words will be read correctly.

The notion of providing children with experiences that bolster reading success has received a great deal of attention in the literature (Bolger, Balass, Landen, & Perfetti, 2008; Martin-Chang, 2009; Share, 1995, 1999). Of notable interest for this paper is the debate on whether words are best read when they are embedded within a meaningful story (context) or when they are presented individually in a list-like format (isolation) (Martin-Chang & Levy, 2005).

Reading in Context vs. Isolation

There continues to be a vested interest in the effects of contextual reading on decoding, orthographic knowledge, and reading fluency (Shahar-Yames & Share, 2008). Research has revealed the added benefits of teaching words in context such that children are found to name more words (including new and difficult words) when they are reading in context than in isolation (Archer & Bryant, 2001; Martin-Chang & Levy, 2005; Martin-Chang, Levy, & O'Neil, 2007; Nation & Snowling, 1998; Nicholson, 1991; Tunmer & Chapman, 1995). In a word-training study, researchers noted that, while both contextual and isolated-word training led to faster and more accurate reading of words, reading words in context showed accuracy benefits over and above reading words in isolation (Martin-Chang & Levy, 2005). Simply put, "children were more successful at reading words in context at every point during training" (Martin-Chang, et al., 2007, p.

52). Such findings are not unique. For instance, LeVasseur, Macaruso, and Shankweiler (2008) also provided evidence of greater gains in fluency following repeated readings in context as opposed to repeated readings in isolation.

The interaction between phonological, orthographic, and contextual information is thought to provide a powerful tool for children who are learning how to read (Binder & Borecki, 2008; Perfetti, 2007). After acquiring rudimentary decoding skills, it is believed that young and struggling readers use the semantic constraints of the context *in combination with* the sound-print information provided by the text to successfully read words they would otherwise be unable to read in isolation (Martin-Chang et al., 2007; Nation & Snowling, 1998; Nicholson, 1991). Nation and Snowling argued that contextual facilitation is the key to resolving ambiguities in decoding difficult words. For instance, when young children are faced with an unknown or difficult word, they will attempt to decode the word according to its orthographic configuration. However, their limited decoding skills may not be enough to successfully read the unfamiliar word. In this case, the benefits of attending to the contextual cues are clear; the meaningful information provided by the surrounding context serves to constrain the possible word outcomes and thus helps to resolve the decoding ambiguity. Contextual facilitation helps developing readers to arrive at the correct word more often than when reading in isolation; therefore, children experience greater reading success from reading in context. As a result, children receive increased exposure to the correct pronunciation of words alongside their appropriate orthographic forms, which facilitates the formation of lexical representations in memory as described by the self-teaching hypothesis (Bus & van IJzendoorn, 1999; Share 1995, 1999; Tunmer & Chapman, 1995).

Yet, the debate is not as one-sided as it initially appears. For instance, while developing readers have been found to read words presented in stories more fluently, contextual information does not seem to enhance reading to a similar extent in all children. Results from Nicholson's (1991) study provide an example of this possible limitation. Developing readers in his study were initially given words to read in either context or isolation and word-reading accuracy was then measured in a new context or list. The findings revealed that 7- and 8-year-old good readers did not show any gains in accuracy when reading in a new context, regardless of whether words were first seen in context or isolation.

Word decoding ability plays an important role in understanding Nicholson's (1991) results. For instance, Tunmer and Chapman (1995) noted that mostly beginning readers with emerging to moderate decoding skills displayed significant gains from reading words in context. It is plausible that older, more experienced readers have many well-established lexical representations and strong decoding skills and thus, rely less on contextual information to read words in stories. On the other hand, these findings are contrasted by studies that found skilled readers making equivalent (Martin-Chang & Levy, 2005) or greater (Nation & Snowling, 1998) reading improvements than their less-skilled peers in context as opposed to isolation.

Nevertheless, if contextual reading is in fact "better" than isolated-word reading at providing opportunities for reading success, then one would expect reading in context to be superior in all instances of the reading development process. This is not the case. Specifically, there has been concern over the long-term learning and retention of words read in context (Landi, Perfetti, Bolger, Dunlap, & Foorman, 2006). Researchers have suggested that in order to acquire proper lexical representations in memory, the reader must attend to the word's form in print and link the orthographic letter string to its correct phonological pronunciation (Cunningham, Perry, Stanovich, & Share, 2002; Share, 1995, 1999). It is possible that contextual reading may interfere with this type of 'self-teaching' process. Landi et al. argued that reading in context detracts the reader's attention from the print information resulting in poorer word retention. Particularly, Landi and her colleagues found that children who read words in context were unable to read them at a later time when they were shown in isolation. It appears as though the children had not actually *learned* the words even though they had previously read them correctly in context. According to their findings, the authors stated that context facilitates reading by providing top-down support; however, in doing so, it focuses the reader's attention on the semantic information of the story to the detriment of attending to the word's letter-sound properties. Landi and her colleagues, then, justified their findings by arguing that readers failed to consolidate the appropriate orthographic and phonological information in memory because fewer cognitive resources were attending to the word's written form in context.

Reading in isolation relies exclusively on the word's printed configuration. The absence of a semantic context increases the attention that is paid to a word's orthographic and phonological properties during isolated-word reading. In support of this statement, researchers have found that words initially read in isolation were retained for longer periods of time in comparison to words read in context (Landi et al., 2006; Martin-Chang & Levy, 2006). In congruence, other studies have found that children learn more words in isolation than in context (Ehri & Roberts, 1979; Johnston, 2000). For example, Johnston had first grade students read words in varying levels of contextual facilitation and in a word bank. The results showed not only greater word learning for words presented in isolation (i.e., word bank), but also a negative relationship between word learning and context, such that word learning decreased as contextual cues increased.

The Role of Semantics during Reading

The benefits of contextual and isolated-word reading continue to be deliberated in the research community. While resolving the context – isolation debate is beyond the scope of this paper, it is important to better understand why such differences occur. Simply stated, how does one make sense of the seemingly divergent findings from studies investigating the benefits of reading in context and isolation?

Indeed, both context and isolation reading conditions supply the reader with the letter-sound properties of the print; however, only contextual reading provides a semantic envelope that helps situate the word's usage and meaning. Accordingly, it has been argued that the semantic information provided during contextual reading (along with decoding) may help readers achieve the correct pronunciation of a word more often than simply decoding alone (Martin-Chang et al., 2007; Nation & Snowling, 1998). Semantics involves the meaning of words as well as the culmination of 'meaning' information that comes about when words are combined into phrases, sentences, and passages (Scarborough & Brady, 2002). As mentioned previously, the semantic information encapsulated within the context of a story is thought to be responsible for providing more opportunities for successful reading experiences, which are necessary for literacy development in children (Nation & Snowling, 1998).

Do children actually utilize semantic information to improve word reading accuracy? Researchers seems to think so; there has been a recent surge in studies investigating the potential role of semantic processing (i.e., the activation and engagement of semantic information) in reading development (Binder & Borecki, 2008; McKay, Davis, Savage, & Castles, 2008; Nation & Cocksey, 2009a, 2009b; Nation, Angell, & Castles, 2007; Ouellette & Fraser, 2009; Perfetti, 2007; Reimer, Lorsbach, & Bleakney, 2008). Moreover, Perfetti's (2007) hypothesis regarding the quality of lexical representations attributes literacy development to the successful integration of phonology, orthography, *and* semantics.

Many studies to date have explored the role of semantics in reference to its impact on reading accuracy and orthographic learning. Thus far the results have been somewhat conflicting; some studies have been able to support a favourable impact of semantic information on oral word reading accuracy (McKay et al., 2008) and orthographic learning (Ouellette & Fraser, 2009), while others have failed to reveal such benefits in word reading (Nation & Cocksey, 2009b) and orthographic learning (Nation et al., 2007).

Fewer studies have examined whether semantic information is differentially activated during contextual and isolated-word reading. This theoretical shortcoming may be the key to better understanding the benefits of reading in context and isolation. Consequently, it is important to briefly review some of the literature that has found evidence of semantic processing in various reading conditions. Nation and Cocksey (2009a), for example, assessed semantic activation from sub-word orthography in 7-year-old children. In this study, children read a series of words in which half were 'carrier' items – words that were embedded with target sub-words (e.g., *hip* in s*hip*; *crow* in *crown*) and half were 'control' items – word without embedded targets. After reading each word, children were then required to make category decision about whether the word belonged to a particular category (e.g., body part in s*hip*?). The results demonstrated slower and less accurate classification of carrier words than control words (Experiment 1) as well as semantic interference in response to carrier words (Experiment 2). In other words, the children's performance was affected by the semantic properties of the embedded target words. Based on these results, the authors argued that semantic processing was indeed present during visual word recognition, and, that the processing of word meaning was sufficiently activated at a sub-word orthographic level. To a certain degree, this study provides evidence for semantic involvement during isolated-word reading.

In another study (Binder & Borecki, 2008), participants read short passages that contained either a correctly used target word ("[...] slam on the *brake*"), an incorrect homophone ("[...] slam on the *break*"), or an incorrect orthographically similar word ("[...] slam on the *bread*"). As expected, reading times were faster when passages contained the appropriate target word. Interestingly, however, the reading times of skilled adult readers did *not* differ for passages that included an orthographically similar homophone as opposed to the correct target word (e.g., *break* instead of *brake*). That is, the performance of skilled readers was not affected by the incorrect, yet similarly spelled, homophone. In light of these findings, the authors postulated that the performance of the skilled adult readers was not affected by the homophones because they sounded identical to the target words; thus, participants were able to retrieve the word meaning that was appropriate for the passage based on its phonological code (e.g., read *break* in passage but retrieved the meaning of *brake*). The authors concluded that the skilled adult readers were processing the passages in a semantic fashion since both the target word and the homophone were equally successful (based on reading speed) at activating the meaning that was appropriate for the context. The results of the Binder and Borecki study provide evidence for semantic processing via contextual reading. In sum, findings of the aforementioned studies (Binder & Borecki, 2008; Nation and Cocksey, 2009a) support the notion that semantic processing plays an important role during the reading process.

Cognitive Processes

The impact of activating cognitive processes (e.g., semantic processing) during reading is now being examined in terms of the context – isolation debate. This is the focus of the present investigation. It has been posited that differences in processing demands may account for the reading performance disparities found between contextual and isolated-word reading in children (Martin-Chang et al., 2007). More to the point, Martin-Chang and her colleagues argued that a processing advantage might occur when both *training* and *testing* conditions elicit similar processes. For instance, Landi et al. (2006) and Johnston (2000) reported greater retention and improved word learning when both training and testing phases took place in isolation.

In a series of experiments, Martin-Chang and her colleagues (Martin-Chang & Levy, 2005, 2006; Martin-Chang et al., 2007) examined the reading performance of children who had been trained and tested in various experimental conditions. The testing period involved successive reading trials, which occurred over several days. During this time, children read – with help from the experimenter – a series of target words that were presented in context (e.g., story) or isolation (e.g., flashcard). The testing session took place on the last day and involved no assistance from the experimenter. In this case, children read the same set of target words (trained words) in either a new story or a new series of flashcards.

The authors reported that when words were first trained in *isolation*, they were later read more fluently in *isolation* (Martin-Chang & Levy, 2006); however, when words were initially trained in *context*, they were read more fluently when tested in *context* (Martin-Chang & Levy, 2005; Martin-Chang et al., 2007). That is, the benefits of initial training were maintained when the same words were transferred and tested in a congruent reading condition. On the other hand, training in one condition (e.g., context) and later testing in a different condition (e.g., isolation) resulted in a slight decrease in reading fluency. In these cases, processing advantages were not readily transferred when training and testing phases were dissimilar.

These results are consistent with a transfer-appropriate processing (TAP) account of reading fluency. According to the TAP theory, performance will be enhanced to the extent that the training and testing phases tap into similar processes (Rajaram, Srinivas, & Roediger, 1998). TAP effects were clearly present in Martin-Chang's studies (Martin-Chang & Levy, 2005, 2006, Martin-Chang et al., 2007): When words were both trained and tested in a congruent fashion they were read more fluently at test because the cognitive processes engaged during encoding and retrieval were extremely similar. Since words initially read in context were later read more fluently in a new context (and vice versa for isolation), TAP theory also supports the idea that contextual and isolated-word reading engage different processes. Presently, however, very little research has examined the specific cognitive processes that are elicited by contextual and isolated-word reading.

In light of this gap, the current study investigated the processes engaged by children and adults when they are reading words in context and isolation.

Considering that every known word conveys an associated meaning, Roediger, Weldon, and Challis (1989) have made a point of stating that semantic information is always active during the reading process. Semantic processing (also referred to as *conceptual processing* in the memory literature) involves the elaboration of meaning-based information. Conceptual processes are utilized when information is engaged according to its semantic properties and affiliations in memory (Blaxton, 1989; Craik & Lockhart, 1972; Craik, Moscovitch, & McDowd, 1994; Jacoby, 1983). To put semantic processing into perspective, researchers often differentiated it from perceptual processing, which is very data-driven. Perceptual processes are activated by the physical and surface features of the material, such as the visual print-related properties of words (Craik & Lockhart, 1972; Craik et al., 1994; Jacoby, 1983; MacLeod, 1989; Rajaram & Roediger, 1993). Semantic and perceptual processes are often viewed as two extremities on a continuum (Craik et al., 1994). While the presence of one processing type does not necessarily mean the absence of the other, Craik and his colleagues (1994) have noted that some processing trade-offs do occur. For instance, increased focus on semantic elaboration may overshadow perceptual information.

One of the most common ways in which researchers have examined cognitive processing is by testing participants' memory for previously exposed information. Particularly, explicit and implicit memory tasks have provided a consistent and efficient means of assessing the semantic and perceptual processes utilized during various experimental conditions (Roediger et al., 1989). The merit of using memory tests to evaluate cognitive processes lies in their different retrieval orientation; explicit and implicit tests of memory engage different cognitive processes during retrieval. Researchers have thus argued that these memory tasks are sensitive to the different types of processes utilized during encoding. For example, explicit retrieval instructions predispose an individual to access semantically-processed information (Craik et al., 1994).

Explicit memory tasks (e.g., recognition, free recall) involve asking a participant to overtly remember information (words, objects, events, etc) previously encountered (Roediger et al., 1989). Research has shown that explicit memory (memory *with* intention) is greatly affected by the degree of elaborative processing of meaning engaged during encoding (Craik & Lockhart, 1972; Craik et al., 1994; Rajaram et al., 1998). In other words, performance on explicit memory tasks is enhanced to the extent that information is processed semantically.

In contrast, implicit memory (memory *without* intention) has been shown to be greatly influenced by perceptual processes (Craik & Lockhart, 1972; Craik et al. 1994; MacLeod, 1989; Roediger, 1990). Implicit measures of memory (e.g., word-fragment completion, word-stem completion) refer to tasks that make no overt link to a previous experience (Roediger et al., 1989). In fact, participants do not realize that their memories are being accessed during implicit tasks; yet, their performance on these tasks is affected by these unconscious memories. To summarize, performance on explicit memory tasks is enhanced to the extent that information is processed semantically whereas performance on implicit memory is data-driven and thus highly susceptible to perceptual features and surface cues.

In a classic study, Jacoby (1983) investigated the cognitive processes engaged when reading in three experimental conditions. Participants named words in (a) isolation (e.g., *Hot*), (b) the context of an antonym pair (e.g., Cold – *Hot*), and (c) generated words from an antonym (e.g., Cold – ___). Jacoby made use of memory tasks in order to assess the different cognitive processes activated during the initial word exposure phase. On the explicit task, Jacoby found that generated words were recognized significantly more than words in context, which, in turn, were recognized to a greater extent than words read in isolation. On the other hand, the implicit identification task showed the opposite pattern; words read in isolation were identified more than words read in context, and generated words were least likely to be identified.

Jacoby (1983) argued that processing differences accounted for the double dissociation in his study. In order to explain participants' explicit memory performance (a task that is sensitive to elaborative processes), Jacoby postulated that generating words required participants to semantically retrieve these words from memory, and, in doing so, participants were engaging semantic processes (Blaxton, 1989; Craik & Lockhart, 1972; Craik et al., 1994). Conversely, he argued that words read in isolation were recognized least of all because they did not activated elaborative meaning-based processes during the reading phase (Blaxton, 1989; Craik & Lockhart, 1972; MacLeod, 1989). These results are also in line with a TAP framework (Rajaram et al., 1998). Specifically, performance on the explicit task was greatest for the generation condition because semantic processes were utilized during both training and testing phases.

On the other hand, when participants read words in isolation they relied heavily on the visual characteristics of the target words in the absence of semantic cues (Jacoby, 1983). In accordance with TAP theory, both the encoding and retrieval phase elicited similar perceptual processes (Blaxton, 1989; Craik & Lockhart, 1972; Craik et al., 1994; MacLeod, 1989). This explains the superior identification of words that were read in isolation on the implicit memory task (a task that is sensitive to perceptually processed information).

To further reiterate, researchers have shown that effortful and purposeful memory (i.e., explicit) is sensitive to semantic processing whereas unintentional memory (i.e., implicit) is affected by perceptual processing. Based on the concurring evidence mentioned above, it is also understood that generating words from meaning-based information elicits a great deal of semantic processing whereas reading words in isolation focuses on visual and surface features that activate perceptual processes. However, the semantic information that is obtained from reading an antonym pair is presumably different from the contextual constraints provided by a coherent story. It is thus unclear how the semantic and perceptual features of words read in a story context are processed in relation to the processing of words read in isolation.

Martin-Chang, Levesque, and Ladd (2010) investigated this issue with undergraduate students over a series of three experiments. Participants in these studies generated words from definitions (generation), read words in stories (context), and read words in lists (isolation). The researchers found that words read within the context of story were explicitly recalled more than words read in a list (Experiment 1). Conversely, implicit memory performance was benefited by the isolated-word reading condition (Experiment 2). These findings were further supported by Experiment 3, which utilized a completely within-subject design (i.e., participants received both the explicit *and* implicit memory tests). The results of Experiment 3 are interesting considering that words read in context and words read in isolation elicited a different pattern of retrieval on the explicit and implicit memory tests. For instance, the target word *umbrella* was more likely to be explicitly recalled when it was initially presented in a story; yet, for the same individual, this 'story word' was not likely to be used on the implicit word-stem task. If, however, this same target word (*umbrella*) was originally read in isolation, it had a greater chance of being used to complete the word-stem "*umb*". It is clear from these experiments that reading words in context and isolation engages a different set of processes. Specifically, the authors argued that contextual word reading was a more semantically-driven activity than isolated-word reading, which, for its part, engaged greater perceptual processes (Martin-Chang et al., 2010)

The Present Study

The results of Martin-Chang and her colleagues (2010) offered an important piece of information towards the context – isolation debate: The initial reading condition has a large impact on how the words are processed by the reader. However, their experiments were carried out exclusively on university undergraduate students. It is unclear whether or not younger children process words in a way that is comparable to that found with undergraduates. To address this issue, we asked three distinct groups of participants (younger children, older children, & undergraduates) to read words in a story and in a list. Based on developmental research, it was predicted that participants' reading abilities and working memory capacity would improve across age groups (Hypothesis 1).

Explicit and implicit memory tests were used to measure the cognitive processes elicited during the experimental reading procedure. Since explicit memory improves from childhood to adulthood as a result of developments in strategy use and metamemory (Kail, 1990; Perez, Peynircioğlu, and Blaxton, 1998; Pressley and Schneider, 1997), it was expected that performance on the explicit recall task would increase as a function of age (Hypothesis 2). In contrast, implicit memory is relatively stable across the lifespan (Komatsu, Naito, & Fuke, 1996; Naito, 1990; Roediger, 1990; Russo, Nichelli, Gibertoni, & Cornia, 1995). Thus, developmental changes in implicit memory performance were not expected across the different age groups (Hypothesis 3).

The primary purpose of the current study was to investigate the cognitive processes engaged by children as they read words in context and isolation. Specifically, I was interested in whether school-aged readers would exhibit differential semantic and perceptual processing in response to contextual and isolated-word reading, and, whether this pattern of processing would resemble that observed in adult readers. If the groups performed according to previous research (Martin-Chang et al., 2010), it was expected that contextual words would be recalled more on an explicit memory task (Hypothesis 4) whereas words read in isolation would be advantaged on an implicit memory task (Hypothesis 5).

Method

Design

This experiment employed a within-subject experimental design. Each participant read a total of 20 target words. Ten different words were read in two conditions (i.e., 10 in context and 10 in isolation). After completing the reading, each participant completed a surprise explicit recall task, followed by an implicit word-stem completion task.

Participants

A total of 67 individuals were recruited from a large metropolitan city in Central Canada and assigned to one of three groups according to their age. The youngest group was comprised of 22 children (9 girls, 13 boys) aged between 7 and 9 years old (M_{age} = 7.59 years, SD = 0.67). A second group of older children included 21 students (15 girls, 6 boys) between 10 and 13 years old (M_{age} = 11.19 years, SD = 1.03). Finally, the oldest group consisted of 24 university undergraduates (12 women, 12 men) between 18 and 35 years old (M_{age} = 23.13 years, SD = 4.24). Participants received either a small gift (e.g., hockey card, chapter book, etc) or a $10 stipend for their participation. All participants were fluent in English and did not possess any significant developmental delays.

Although the children in the youngest group are still considered to be developing readers, they were deemed appropriate for the current study because past research has demonstrated that by Grade two (the lowest grade level included in this group) children have already established a foundation of phonological and orthographic skills and have the ability to benefit from contextual constraints during the word decoding process (Bus & van IJzendoorn, 1999; Share, 1995). In addition, average readers in this age bracket have previously demonstrated their ability to independently read words in stories and lists with sufficient accuracy (Martin-Chang et al., 2007).

Children in the younger group were given the reading subtest of the Wide Range Achievement Test – Third Edition (WRAT-3; Wilkinson, 1993). By administering the reading subtest of the WRAT-3, we were able to measure the reading skills of our younger participants and select a group of "good readers". As such, the resulting 22 younger participants were selected from a larger sample (n = 47) based on their superior

WRAT-3 scores (having a standardized score that is one or more standard deviation above the mean). This additional inclusion criterion helped to further guarantee that the younger children possessed the skills necessary to successfully complete the reading tasks. It is important to note that although the WRAT-3 reading test was administered to all participants regardless of age, the scores of the older children and undergraduates were not used to exclude any participants from their respective groups. The mean scores on the WRAT-3 reading test for all three groups can be found in Table 1.

The two remaining groups of participants (older children and undergraduates) were included because some researchers have failed to find any evidence of semantic benefits on explicit recall tasks in younger grades (e.g., Komatsu et al., 1996). Authors such as Perez et al. (1998) have noted that explicit memory develops during childhood and that performance on tasks that tap into explicit memory improves with age. Older participants should therefore display greater recall scores on the explicit memory task. Moreover, these older groups (especially the undergraduate students) have accumulated a greater amount of reading experience, which should translate into greater reading ability (Perfetti, 2007). As a result of greater reading fluency, meaning-based processing could be greater in the older groups because they are not expending as many cognitive resources on basic decoding attempts. Finally, the inclusion of undergraduate (i.e., adult) participants in this study enabled a comparison of this study's findings with those of Martin-Chang et al. (2010).

Materials

All participants were exposed to target words in two experimental reading conditions: in context and in isolation. To achieve this, a total of 40 target words were selected from existing materials described in Martin-Chang and Levy (2005) and divvied into four mutually exclusive sets of 10 target words (Set 1, 2, 3, & 4; see Appendix A for target sets and their average word frequency per million words).

Contextual reading condition. For the *context* condition, target words were embedded within one of two short stories utilized in Martin-Chang and Levy (2005). Target words from Set 1 and Set 2 were used in the creation of the story "First Class" (Appendix B & C) whereas Set 3 and Set 4 were integrated into the story "Halloween" (Appendix D & E). Each target was repeated twice it its respective story, resulting in 20 (2 x 10) target word exposures in each context. The stories ranged between 558 – 582 words in length and grade 3.6 to grade 4.1 level of reading difficulty (as analyzed by the Flesch-Kincaid formula). The stories were typed in Times New Roman size 14 Font and printed on 8½ x 11 white paper. Target words were bolded and underlined in order to make them noticeable from the surrounding print.

Isolated-word reading condition. For the *isolation* condition, 10 target words were presented individually on a computer screen. Targets were written in Times New Roman size 66 Font and displayed at the center of the screen. Targets were shown twice in random order, resulting in 20 (2 x 10) target word exposures. Each target word was presented for a total of two seconds followed by two second delay. During this delay, a fixation point was displayed at the center of the screen.

Memory tests. In order to measure the engagement of semantic and perceptual processes, the present study included two distinct memory tests: a surprise explicit recall test and an implicit word-stem completion task. The explicit recall task required participants to verbally recall as many of the target words as possible. Verbal recall was deemed more appropriate than written recall considering that the youngest children were likely to have less-experienced writing and fine motor skills, which could have inadvertently hindered their performance on the memory task. It also ensured that participants did not receive additional exposure to any target words outside of the contextual and isolated-word reading condition. All answers were recorded by the experimenter on a score sheet.

The word-stem completion task is an implicit memory tasks that requires participants to quickly generate a response based on the first three letters of a word (the stem). The task included a total of 30 stems, 20 of which were derived from the target words presented in context and in isolation (i.e., words that were read aloud by the participant) as well as an additional 10 stems from a 'control' set of target words (i.e., words that were *not* seen by participants). Similar to previous studies (e.g., Martin-Chang et al., 2010), word-stems were represented by the first three letters of the target words (e.g., *tea*___ for *teacher*). However, the implicit word-stem task in this study was modified in two important ways: first, the word-stems were presented individually on the computer for a period of 10 seconds each. The stems were displayed at the center of the screen and were written in Times New Roman size 66 Font. Second, instead of simply generating one word per stem, participants were allowed to generate as many words as possible that 'fit' each words-stem during the 10 second period. All answers were recorded on a score sheet.

Reading pretest. The Wide Range Achievement Test – Third Edition (WRAT-3) is a standardized test that measures the general skills of word reading, sentence comprehension, spelling, and math computation (Wilkinson, 1993). The test is appropriate for individuals between the ages of 5 and 94 years old. Only the word reading subsection of the WRAT-3 was utilized for the current study. The reading test measures an individual's ability to read words; the task consists of 15 letters and 42 individual words of increasing difficulty that the participants are asked to name or pronounce. A score of 1 is given to all correct answers, which are then summed to calculate a total score.

Working memory test. The Woodcock Johnson III Tests of Cognitive Abilities (Woodcock, McGrew, & Mather, 2001) are designed to assess individuals' general intelligence ability as well as many specific cognitive factors (e.g., processing speed, long-term memory, etc.). The Woodcock Johnson III (WJ-III) was normed on a sample of 8,818 children and adults (2–90+ years), and is commonly used in the research community. Though the Standard Battery includes a total of seven tests, the current investigation utilized the Numbers Reversed test to measure participants' working memory. The test requires participants to hold increasingly difficult span of numbers in their short-term memory while attempting to reverse the sequence in which the numbers were original presented. The median reliability scores for this test are .86 for individuals aged 5 to 19 years and .90 for adults.

Procedure

Individual testing was carried-out by trained experimenters. Consent to participate was provided in writing by either the participants (adults) or their guardians (children). The location of the testing was scheduled at the participant's convenience. Testing was carried out in a quiet room at the participants' school/university or at an alternate location, such as their home or the home of a friend.

Without divulging the memory component of the study, the participants were informed of the general purpose of the investigation; the students in the youngest group were told that they would be playing a "reading game" in which they would be reading words in a story and from the computer screen. Similarly, the remaining older groups were told that they would be reading many words throughout the course of the session; however, in order to acknowledge the potential perceived simplicity of the tasks, the older children and undergraduates were also informed that their participation would assist in establishing a baseline score for comparison purposes. All participants were asked to direct their full attention to the activities and perform to the best of their abilities. The tasks occurred in the following order: WRAT-3 reading test, reading conditions (context & isolation), surprise explicit recall, WJ-III Numbers Reversed, and implicit word-stem completion. The order of the reading conditions and the four material sets were counterbalanced across all participants (see Appendix F for counterbalance).

The testing session began with the WRAT-3 Word Reading test. Participants were presented with 42 words of increasing difficulty and asked to read the words aloud, from left to right down the page, to the best of their ability. No feedback was provided. The task ended when participants read 10 consecutive items incorrectly or read all the words on the page. For scoring purposes, one point was given for every word read accurately.

Next, participants were exposed to a total of 20 target words through two experimental conditions: 10 target items were embedded within the context of story and 10 words were presented in isolation on the computer screen. The order of presentation (context – isolation; isolation – context) was counterbalanced throughout the study. The target word sets (Sets 1-4) were also counterbalanced across participants so that all targets words were used equally for contextual, isolation, and control conditions. For instance, if a participant was presented with the story *First Class* (e.g., Set 1), he/she would have received either Set 3 or Set 4 in isolation. Likewise, if a different participant was assigned to read the story *Halloween* (e.g., Set 4), they would have read target words from Set 1 or Set 2 in isolation (see Appendix F for complete counterbalance). Importantly, Sets 1 and 2 (and likewise Sets 3 & 4) were never presented together within one testing session as they corresponded to the same story

Words presented in context were read within a short story. A shared reading procedure was employed whereby the experimenter read the majority of the story and the participants read only the 20 words (10 targets x 2 exposures). Participants were asked to follow along with their finger as the reading took place. This was done to replicate the procedure typically followed with children. In addition, it prevented participants from fixating on the target words for extended period of time. Paying attention to the story was further stressed as participants were informed that they would potentially be asked comprehension questions following the completion of the passage. One 'Yes or No' question was asked orally after the story had been read; this question did not contain any target words. The researcher recorded participants' responses on a score sheet.

Words read in isolation were presented individually at the center of a computer screen. More specifically, each word was seen for a total of two seconds followed by a two second delay between the targets words. Participants were asked to read the words aloud to the best of their ability as they appeared on the screen. Before seeing the actual target words, participants were shown two examples (e.g., dog, bird) so that they would be familiar with the timing and format of the presentation.

The experimenter recorded the reading accuracy of the target words on a score sheet. Reading accuracy was at ceiling (100%) for the undergraduate participants. Errors seldom occurred in the groups of younger and older children (98.72% accuracy) because the target words were appropriate for those grade levels. Nevertheless, on the rare occasion that a target word was read incorrectly, the experimenter promptly provided the correct pronunciation. It is noteworthy that participants successfully incorporated the experimenter's feedback and corrected their responses on the subsequent encounter with a misread target word. That is, children were successful at reading a target word during its second exposure if they had been provided with corrective feedback during the first encounter with the target. Reading accuracy was thus at ceiling during the second target word exposure for both school-aged groups.

Immediately following the reading conditions, a surprise explicit memory task was administered. Participants were asked to verbally recall as many of the previously read target words as possible. They were also informed that this task was not subject to a time limit and no penalties would be incurred of incorrect guesses. The experimenter recorded all responses on a separate score sheet. Explicit recall scores were calculated by summing the number of correct responses remembered from each reading condition. A singular target word recalled in its plural form (or vice versa) was scored as correct (e.g., target *sticks* = recalled *stick*). For the most part, however, a very strict scoring criterion was adhered to (e.g., target *broke* ≠ recalled *broken*; target *warning* ≠ recalled *warned*). As a precaution, participants were asked if they were aware of the study's memory component or otherwise knew to remember the target words that were being read. The answer to such questions was "no" for all participants.

Next, participants received the WJ-III Numbers Reversed test (Woodcock et al., 2001). The working memory task required the experimenter to dictate a string of numbers of increasing length (e.g., *2…8…4*). Participants were asked to pay attention to the numbers and repeat them aloud in reverse order (e.g., *4…8…2*). Participants were provided with two examples before officially beginning the task. The test continued until the three highest-numbered items in a group were answered incorrectly. A total score was then calculated by summing all correct responses.

Finally, the implicit word-stem completion memory test was administered. Participants saw 30 word-stems in random order and were asked to complete each stem with as many words as possible during the allotted 10-second period. They were informed that the stems varied in level difficulty, but that each item could potentially be answered with multiple correct responses. The only restriction to this task was to avoid proper nouns (names of people or places). Two example items (e.g., *not*___ ; *lan*___) along with several possible answers (e.g., *nothing, notebook; language, land*) were provided prior to starting the task. Participants generated their answers orally while the experiment recorded them verbatim on a separate score sheet. Responses were scored as correct when the word-stem was completed with a previously read target word. The scoring criteria were identical to those used for the explicit recall test.

Individuals were thanked for their participation and given a small gift (e.g., book; school-aged groups) or a $10 stipend (undergraduate group) for their assistance. The duration of the entire testing session was approximately 25 minutes.

Results

The present study required participants to read a series of target words in context and isolation, and subsequently to complete two measures of memory. Prior to conducting the analyses on the explicit and implicit memory scores, the participants' performance on the WRAT-3 reading subtest (Wilkinson, 1993) and the Woodcock-Johnson III Numbers Reversed task (Woodcock et al., 2001) was assessed. The results from the reading and working memory tests for the three age groups are presented in Table 1. As predicted (Hypothesis 1), the performance on both tests improved across age groups. Two separate one-way analyses of variance (ANOVA) confirmed these differences to be significant (WRAT-3 reading test, $F(2, 66) = 110.48$, $MSE = 1529.13$, $p < .001$, $\eta^2 = .77$; WJ-III Numbers Reverse task, $F(2, 66) = 62.52$, $MSE = 693.25$, $p < .001$, $\eta^2 = .66$). Post-hoc analyses (with the Bonferroni correction in place) revealed that all groups differed significantly from one another on their reading skills (all comparisons $p \leq .001$) and working memory capacity (all comparisons $p \leq .002$).

Table 1

Descriptive Statistics of the WRAT-3 Reading Test and WJ-III Numbers Reversed as a Function of Age Group

Test	Younger Children ($n = 22$)	Older Children ($n = 21$)	Undergraduate Students ($n = 24$)
WRAT-3 Reading Test			
Mean	35.05	39.43	50.75
SD	3.18	4.27	3.63
Min – Max	30 – 42	29 – 48	41 – 57
WJ-III Numbers Reversed			
Mean	10.23	13.90	21.00
SD	2.27	2.72	4.44
Min – Max	5 – 6	10 – 19	12 – 29

Note. WRAT-3 = Wide Range Achievement Test- 3rd Edition; WJ = Woodcock-Johnson.

The main goals of the current investigation were to examine the processes elicited during contextual and isolated-word reading. In order to meet these goals, four separate mixed-design ANOVAs were conducted. Two sets of analyses were performed for each memory task – the first set of analyses use a stringent scoring method while the second set used a more lenient approach of scoring.

Explicit Memory

Table 2 shows the mean number of target words explicitly recalled from the contextual and isolated-word reading conditions. The stringent scores shown in this table are represented in percentages, which were obtained by summing the number of target words from each condition and dividing this total by the number of words in a set (i.e., 10). The extent to which these target words were explicitly remembered from the story and the list was used to address Hypothesis 4, namely that words read in context would be recalled more than words read in isolation. As depicted in Table 2, words read in isolation were explicitly recalled more than words read in context in all three participant groups. A 2 × 3 mixed ANOVA where the within-subject factor was reading condition (context & isolation) and the between-subject factor was age group (younger children, older children, undergraduates) was performed to assess the explicit recall performance of the participants. The analysis confirmed a main effect for reading condition, $F(1, 64) = 11.37$, $MSE = 29.92$, $p = .001$, $\eta^2 = .15$, however, contrary to the hypothesis, the ANOVA indicated that participants recalled significantly more words from isolation than context.

As expected, age group played a role on the total number of words explicitly remembered (Hypothesis 2). The mixed ANOVA revealed a significant main effect for age group on the total number of words recalled, $F(2, 64) = 4.53$, $MSE = 12.74$, $p = .014$,

$\eta^2 = .12$. Specifically, undergraduates remembered the greatest number of 'context' and 'isolation' target words; they recalled an average of 7.54 words on the explicit memory task out of a possible 20 target words (37.70%). The group of older children had the second highest rate of recall with an average of 6.33 words remembered (31.65%) followed by the youngest group of children who recalled the least number of words at an average of 5.45 words in total (27.25%).

The interaction between reading condition and age group was not significant, F (2, 64) = .08, MSE = .21, p = .92, $\eta^2 = .00$, indicating that the overall pattern of recall (isolation > context) was similar among all three groups. Finally, post hoc comparisons (with the Bonferroni correction in place) were performed on the main effect found for age group. The analyses established that the younger children and undergraduate groups were significantly different from one another (p = .012). No other pairwise comparisons reached significance.

Table 2

Percentage of Target Words Remembered on the Explicit Memory Test as a Function of Age Group

Reading Condition	Younger Children	Older Children	Undergraduate Students
	M % (*SD*)	*M* % (*SD*)	*M* % (*SD*)
Explicit			
Context	22.27 (*13.78*)	26.19 (*15.32*)	33.75 (*17.64*)
Isolation	32.27 (*16.60*)	36.67 (*13.17*)	41.67 (*20.57*)

A similar set of analyses were conducted using data obtained through a more lenient scoring method. Specifically, *non-target* contextual words (i.e., words that were contained in the story but not read by the participant) that were recalled by the participants were added to the existing context scores and included in the analyses. In comparison to the explicit context means found in Table 2, the lenient context scores for younger children, older children, and undergraduates were 27%, 34%, and 41%, respectively. When taking these means into account, a 2 × 3 mixed ANOVA failed to reveal a significant main effect for reading condition, $F(1, 64) = .80$, $MSE = 252.70$, $p = .38$, $\eta^2 = .01$. In other words, words read in context and isolation wecre recalled to a similar extent.

Similar to the analyses performed on the data from the stringent method of scoring, a significant main effect for age group was found, ($F(2, 64) = 4.02.80$, $MSE = 1630.13$, $p = .02$, $\eta^2 = .11$), and subsequent post-hoc analyses revealed that undergraduate participants recalled more words than the younger children ($p = .018$). Once again, the remaining group comparisons did not reach significance. Finally, there was no significant interaction between reading condition and age group, $F(2, 64) = .23$, $MSE = 73.54$, $p = .79$, $\eta^2 = .01$

Implicit Memory

The context and isolation scores obtained by each group on the implicit word-stem completion task are presented in Table 3. These scores were obtained by using a stringent scoring method (i.e., one point was awarded when target words were named as the first word to complete the stem; however, no points were given when the target word was listed later in the sequence). In general, the words read in isolation were most likely to be used to complete the word-stems; almost half of the words seen on the computer screen were verbalized on the implicit memory task regardless of age group. In comparison, approximately 30% of the words read in the story and 20% of the control words were used to complete the words stems. A 3 × 3 mixed ANOVA where the within-subject factor was reading condition (context, isolation, control) and the between-subject factor was age group (younger children, older children, undergraduates) was performed to assess the impact of contextual and isolated-word reading on participants' implicit memory performance. The analyses confirmed a main effect for reading condition, $F(2, 128) = 62.60$, $MSE = 92.60$, $p < .001$, $\eta^2 = .49$.

Unlike the performance on the explicit tasks, the scores of the implicit word-stem task were not discernibly higher in the undergraduate students. Although undergraduates generated the highest amount of target words on the word-stem task ($M = 32.36\%$), they were followed closely by the older children ($M = 32.06\%$) and finally with the youngest children who named the fewest number of targets words on the stem completion task ($M = 31.21\%$). Based on these comparable means, it is not surprising that the mixed ANOVA revealed no significant main effect for age group, $F(2, 64) = .10$, $MSE = .24$, $p = .91$, $\eta^2 = .003$ (Hypothesis 3). Furthermore, there was no significant Reading Condition × Age Group interaction, $F(4, 128) = .57$, $MSE = .84$, $p = .68$, $\eta^2 = .02$.

Post-hoc comparisons (with the Bonferroni correction in place) were performed on the main effect found for reading condition. In support of Hypothesis 5, the results confirmed that words read in isolation were used to complete the word-stems to a greater extent than words read in context ($p < .001$). In addition, control words, which were generated the least, were used significantly less than either reading conditions (all combinations $p < .001$).

Furthermore, the significant memory patterns observed on the implicit task (isolation > context > control) were identical when the lenient method of scoring was adopted (i.e., one point awarded for target words that were named at any point during the allotted 10-second period). Though the means were slightly elevated with the lenient scoring method, words read in isolation were most likely to be used to complete the word-stems most (57%). Contextually-read words were the next likely to be named on the implicit task (44%) followed by control words, which appeared least of all (32%). Once again, a 3 (reading condition) × 3 (age group) mixed ANOVA revealed a significant main effect for reading condition, $F(2, 128) = 45.63$, $MSE = 10012.85$, $p < .001$, $\eta^2 = .42$. Post-hoc analyses (with the Bonferroni correction in place) were significant ($p < .001$) between all pairwise comparisons.

Table 3
Percentage of Target Words Remembered on the Implicit Memory Test as a Function of Age Group

Reading Condition	Younger Children	Older Children	Undergraduate Students
	M % (*SD*)	*M* % (*SD*)	*M* % (*SD*)
Implicit			
Context	29.09 (*13.06*)	30.48 (*10.71*)	32.92 (*13.98*)
Isolation	42.73 (*15.49*)	44.29 (*15.35*)	45.42 (*16.93*)
Control	21.82 (*11.81*)	21.43 (*13.15*)	18.75 (*7.97*)

In contrast to the results reported with the stringent scores, the lenient scoring method showed a main effect for age group on the implicit memory task, $F(2, 64) = 6.45$, $MSE = 2102.89$, $p = .003$, $\eta^2 = .17$. Post-hoc comparisons (with the Bonferroni correction in place) revealed a significant difference between the younger children and undergraduates (p =.002). No other group comparisons reached significance. In addition, the Reading Condition × Age Group interaction was not significant, $F(4, 128) = .84$, $MSE = 184.53$, $p = .50$, $\eta^2 = .03$.

Discussion

Providing children with opportunities that will maximize their reading success is essential (e.g., Cunningham & Stanovich, 1997; Perfetti, 2007; Shahar-Yames & Share, 2008; Share, 1995). It has been posited that successful reading experiences over time help establish high quality lexical representations, which involves the fusion of phonological, orthographic, and semantic information in memory (Perfetti, 2007). There have been questions about whether children are more accurate at reading words in context (e.g., stories) or in isolation (e.g., lists). Certainly, this debate is not without merit; researchers have noted benefits from both contextual and isolated-word reading in children (e.g., Landi et al., 2006; Martin-Chang & Levy, 2005). Based on the transfer-appropriate processing theory, it was hypothesized that the differences in reading performance that stem from reading in context and isolation are the result of differential cognitive processes engaged during the reading experience (Martin-Chang et al., 2007). Recent experiments with undergraduate students (Martin-Chang et al., 2010) have supported this argument but the underlying processes involved during contextual and isolated-word reading in school-aged children had not yet been investigated.

The study reported here compared the semantic and perceptual processing of words read in context and isolation in three different age groups. Tests of explicit and implicit memory were employed to judge the differences in underlying cognitive processes. The main focus was whether processes observed in children would approximate the patterns found in adults; namely, that semantic processes take precedent during contextual reading, whereas perceptual processes are featured prominently during isolated word reading (Martin-Chang et al., 2010).

A surprise recall task was included in the study to measure participants' explicit memory for the previously read target words. It is well established that explicit memory improves with age (e.g., Kail, 1990; Komatsu et al., 1996; Perez et al., 1998; Schneider & Pressley, 1989). Pressley and Schneider (1997) attributed these developmental changes in explicit memory to the greater use of recall strategies, increasing knowledge base, and the development of metamemory. Therefore, it was expected that performance on the explicit memory task would increase as a function of age. Indeed, the total number of words recalled on the explicit task improved across age groups. Adults remembered the greatest number of words whereas the younger group of children recalled the least. Working memory ability also improved across groups. The overall results on the explicit memory task add to the extensive literature showing performance improvements over time as a result of developmental changes in encoding and retrieval strategies (Kail, 1990; Pressley & Schneider, 1997). The explicit findings make a valuable contribution to the literature due the fact that they were obtained from a surprise recall task, which is a less explored form of memory in children (Toppino, Fearnow-Kenney, Kiepert, & Teremula, 2009). In particular, many studies have reported developmental differences when participants were intentionally learning the materials to-be-remembered; however, in this case, participants replicated previous findings through a process of incidental learning.

Yet, one of the main theoretical questions that motivated this study was whether children would exhibit a contextual advantage that is comparable to that observed in adults on an explicit memory task. Based on the previous findings reported by Martin-Chang et al. (2010), it was hypothesized that words read in context would be remembered more than words read in isolation on an explicit test of memory. Unexpectedly, the stringent scoring methods utilized for the surprise recall task showed a significant advantage in the opposite direction; words read in isolation were recalled at a higher rate than words read in context. According to these results, it seems that words read in isolation were engaging proportionally greater semantic processes than words read in context.

If only children had been tested, the scores obtained on the explicit task may have pointed to the notion of developmental differences in word processing. It might have been concluded that children's poorer recall of words read in context resulted from their inability to utilize contextual binding to the same extent as adults. Indeed, several lines of evidence would have supported such an argument. First, Lorsbach and Reimer (2008) found that children were less sensitive to contextual information than adults. As such, their results showed that children often failed to use context cues when attempting to identify target probes within the text. Second, reading fluency differences between good and poor readers also play a role in how they attend to the context. It has been shown that young and struggling readers tend to adopt single-word level focus during reading in comparison to good readers who display evidence of greater text-level reading (Faulkner & Levy, 1994, 1999). Finally, Masson and MacLeod (2000) argued that readers must first be "capable of and oriented toward text comprehension" (p. 1096) for contextual binding to occur. Thus, if children were in fact reading with an increased focus on individual words, then their orientation towards the comprehension of the story as a whole may have been obstructed. If this were the case, heightened semantic processing in context would not be expected.

However, this "reduced contextual-binding" account, while compelling, is incompatible with the fact that the adults showed the same pattern of results on the explicit memory task (i.e., isolation > context) as the children. If the unexpected advantage of words read in isolation was the result of developmental change, then one would have been expected differences across the age groups. The adults in this study would have been expected to replicate the pattern of findings observed previously (context > isolation). The older children should have then exhibited a recall pattern that in transition towards looking more 'adult-like', thereby demonstrating their increasing ability to benefit from contextual binding, and finally, the younger children would have shown the smallest benefits from contextual binding. Given that all three participant groups in this study demonstrated a similar pattern of recall, the results do not support an interpretation of developmental differences in this instance.

The superior recall of 'list' items is at odds with the large body of literature showing that words read in isolation are disadvantaged on tests of explicit memory in comparison to words read in other forms of contextual surround (e.g., antonym pairs, passages, scrambled and coherent texts; Blaxton, 1989; Jacoby, 1983; Martin-Chang et al., 2010; Masson & MacLeod, 2000). This raises the question of why the words read in isolation were remembered better than the words read in context.

It is possible that procedural changes impacted the results on the surprise recall task. In comparison to previous studies with adults (Martin-Chang et al., 2010), the procedures in the current study were simplified so that they could be used with children.

For instance, the delay period between the reading conditions and the explicit recall task was removed in order to reduce the probability that children's performance would be at floor. This change in procedure may have had a differential impact on the two reading conditions. For instance, a cursory inspection of the raw data suggest that the recall of words read in isolation was greatly advantaged when it was presented last; nearly half of the words read in isolation were recalled when this condition appeared last in comparison to only a third of the words when the isolation condition was presented first. Thus, there was a large discrepancy in the number of target words remembered from isolation, which depended heavily on whether those words were read first on last. On the other hand, words read in context were recalled to a similar extent irrespective of whether this condition occurred before or after the isolation reading condition.

These findings allude to the fact that the superior recall of words read in isolation may have been fuelled by a recency effect. The recency effect is commonly reported in the memory literature in reference to its effect on explicit tasks such as free recall (e.g., Baddeley & Hitch, 1993, Howard & Kahana, 1999; Ward, 2002). It is sometimes referred to as "end-of-list" effects as it involves a discernable increase in probability of recall for items (or words) that are presented at the end of a list. Several theories have been proposed to account for the recency effect, however no clear consensus exists at this time (Howard, Venkatadass, Norman, & Kahana, 2007). For example, the recency effect is sometimes described as the immediate "emptying out" of a short-term memory store (Davelaar, Goshen-Gottstein, Ashkenazi, Haarmann, & Usher, 2005) whereas other theories explain that the effects of recency are a result of temporally defined associative processes (Howard et al., 2007). In the current study, a closer look at the order in which contextual and isolated-words were recalled revealed potential evidence of recency effects; isolation words that were seen near or at the end of the list tended to be named first on the explicit task. The presence of recency effects may be a strong contributing factor to the greater recall of words read in isolation.

Why would words in isolation be subject to greater recency effects than contextual words if the reading conditions were counter-balanced throughout the experiment? In the current study, when the isolation condition was presented last, it was immediately followed by the explicit recall test. However, when the context condition was seen last, it was followed by a comprehension question before moving on to the memory task. This is an important distinction because researchers have found that the recency effect is short-lived and can be quickly eliminated by a distractor task (e.g., comprehension question; Howard & Kahana, 1999). In sum, the recency effect may have been more prevalent for words read in isolation because these words – when presented last – were not burdened by an additional task or distractor words, such as the additional non-target words that comprised the story.

It is important to highlight that the study conducted by Martin-Chang and colleagues (2010) did not appear to be affected by recency effects. However, their procedure contained a 10-minute (Experiment 1 & 2) or 5-minute (Experiment 3) delay between the word conditions and the explicit recall task. During this time participants were given filler tasks that did not contain any of the target words. The lag between the words and the memory test seems to have attenuated the problematic effects observed in this study.

In contrast to tests of explicit recall, performance on memory tasks that require no conscious recollection of previous events is influenced by priming effects, which are sensitive to perceptually-processed information (Perez et al., 1998 Roediger, 1990). As such, an implicit word-stem completion test was used to assess the extent of perceptual processing elicited during contextual and isolated-word reading. The results from the implicit task are in congruence with several lines of research. For instance, the developmental invariance of implicit memory has been firmly established in the literature (Komatsu et al., 1996; Naito, 1990; Perez et al., 1998; Roediger, 1990; Russo et al., 1995). In accordance with previous findings, the total number of target words named on the implicit word-stem task was nearly identical across groups. These results support the idea that a memory system beyond explicit awareness is available early in development and remains relatively stable across the lifespan.

Of particular interest to the current investigation, all three groups exhibited a similar pattern on the word-stem task. Namely, words read in isolation were used significantly more often to complete the word-stems than words read in context. Control words, which were never seen, were used least of all during the implicit task. Recent experiments by Martin-Chang and her colleagues (2010) found similar outcomes in that words read in isolation were used significantly more by undergraduates on word-stem tests. Based on their implicit memory data, the authors argued that isolated-word reading engaged perceptual processes to a greater extent than contextual reading. The implicit memory performance of the undergraduate participants in the current study fully replicates those reported by Martin-Chang and colleagues.

Finally, performance of the implicit task revealed similar results regardless of whether the stringent or lenient method of scoring was implemented. The fact that both scoring methods yielded results that were consistent with each other as well as with past research provides support for the following conclusions: a) Isolated-word reading engages greater perceptual processing than contextual reading, and b) the extent of perceptual processing elicited by words read in isolation and context is constant from childhood to adulthood. The latter statement adds a unique contribution to the literature.

Notice that the implicit data points to a different interpretation of the semantic processes elicited during contextual and isolated-word reading. Particularly, the notion of superior semantic processing in isolation is inconsistent with the implicit results: Had the participants engaged deeper, more elaborate processes in isolation (as suggested by the findings on the explicit task), then the likelihood of naming an isolation target word during the word-stem task would have been substantially lower than what was observed. This is because semantic processes have the potential to overshadow the effects of perceptual processing (Craik et al., 1994). Stated differently, the likelihood of identifying isolation words on the implicit memory task would have been negatively affected if these words had been processed in a more semantically-driven manner. Since this was clearly not the case (i.e., the isolation reading condition had the highest score on the word-stem task), it suggests that the words read in isolation were not burdened by much semantic interference on the word-stem task.

The fact that words read in context were less likely to be named on the word-stem task alludes to the possibility that these words were subject to greater semantic processing. In fact, Masson and MacLeod (2000) have noted that "conceptually driven processing involved in reading text does not transfer well to data-driven tests" (p. 1096). Therefore, engaging in deeper and more elaborative processes in context may have caused semantic interference on the implicit word-stem task. Such interference would explain why contextual words were processed less perceptually than words read in isolation, even though both sets of target words were seen in print. In this way the implicit data may provide indirect evidence for greater semantic processing during contextual reading, which would be consistent with the findings of Martin-Chang et al. (2010). However, this account must be interpreted with caution because the explicit data obtained in this study does not support this view.

Limitations and Future Directions

The context – isolation experimental manipulation utilized in this study offered an innovative approach to assessing the different underlying processes that guide contextual and isolated-word reading in children. However, there are several limitations that should be addressed in future research. As described above, the first limitation was the lack of a delay period between the reading conditions and subsequent recall task. Without any delay period, the probability of incurring recency effects was increased. This was especially true for the isolation reading condition, which was greatly advantaged when it was presented last. It is believed that this procedural change was a strong contributing factor to the discrepant results obtained on the explicit memory test. As such, future research endeavors should seek to establish a standard time delay between the reading conditions and the memory test in order to eliminate such recency effects.

Further methodological issues arose during the study. For instance, even though all participants read a total of 40 words during the testing session (10 in context & 10 in isolation; 2 exposures each), the contextual reading condition was inherently more difficult than the isolation condition. Specifically, the target words in context were embedded within stories that ranged between 558 – 582 words in length, which is a significant contrast to the mere 40 words seen in isolation. For this reason, the recall of 'non-target' context words was not uncommon in this study. The explicit lenient scoring method was initiated to take this into account, which resulted in no differences between words read in context and isolation. Moreover, the supplemental 'non-target' words in context inherently made this task substantially longer to complete. The isolation condition took approximately 80 seconds to perform whereas the contextual story was judged to be roughly 200 seconds in duration. It is important that futures studies attempt, as much as possible, to equate these two reading conditions so that recall performance is not encumbered by varying levels of difficulty between contextual and isolated-word reading.

Another limitation of this study that is closely related to task difficulty involved an issue with "processing time". This term is used to describe the total time in which the reader had the potential to actively process a target word. Once again, the design of the study created unequal opportunities to engage each target words. For instance, each target word in isolation was seen for two seconds, followed by a two second delay, and this process was repeated once over. In total, then, participants had the potential to engage each target for eight seconds in isolation. On the other hand, the nature of the contextual reading condition did not allow for extended periods of processing time; that is, once the participant read the target word the experimenter immediately continued reading the story. Future investigations should recognize that the presentation speed used for the isolation condition was perhaps too generous in this study. This is supported by Martin-Chang and Levy (2005) who found that average readers in Grade 2 required less than one second to read individual words in isolation.

The compounded effect of these limitations may have had a greater consequence on the explicit memory test as opposed to the implicit task. This is because explicit recall was always the memory task that followed the reading conditions. Moreover, true implicit memory occurs outside of conscious awareness and should therefore be resilient against the influence of recency effects or varying task difficulty. For instance, researchers have noted that processing time – within limits – does *not* determine the extent of implicit priming effects (Masson & Macleod, 2000). Therefore, the limitations that have resulted from this investigation render the explicit data difficult to interpret with regards to word processing.

Nevertheless, in spite of the abovementioned limitations, the current study marks the first attempt to study the semantic and perceptual processes educed from children reading in different contextual surrounds. Therefore, it remains an important first-step in determining how children process words during contextual isolated-word reading.

Conclusion

The current study was motivated by the resurgence of interest in to the role of semantic processing in children's reading accuracy and orthographic learning (e.g., McKay, Davis, Savage, & Castles, 2008; Nation & Cocksey, 2009b; Ouellette & Fraser, 2009). Moreover, prior to this investigation, information central to informing the context – isolation debate was only available if one generalized the findings of adult readers (Martin-Chang et al., 2010). This is because knowledge about the semantic and perceptual processes elicited by children reading in context and isolation had been unknown until this point. Therefore, the inclusion of school-age children in this study highlights a unique and important contribution to the literature.

In evaluating the overall pattern of evidence in this study, it was found that words read in isolation were significantly advantaged on both memory tests; specifically, target words read in isolation were more likely to be named on the word-stem task than context words. In addition to replicating past research, the implication of this finding suggest that all readers, even those with several years of reading experience (i.e., undergraduates), attend to the perceptual features of words to a greater extent in isolation than in context.

On the other hand, the superior recall of words read in isolation on the explicit memory test – suggesting greater semantic processing in isolation – is in contrast to previous findings. Recency effects stemming from the isolation reading condition may help explain these findings. However, the fact that words read in isolation were subject to longer viewing times than words read in context may have lead participants to think about these words in a more elaborative way. For this reason, it is possible that words read in isolation in this study elicited more semantic processing than words read in the context of a story. But, perhaps reading under more normal, non-contrived circumstances would reveal different results considering that "it is extremely difficult for a skilled reader to process texts in any way that defocuses message meaning" (Levy, Masson, & Zoubek, 1991, p. 502). This presents an important question for future research.

Yet, the primary focus of this investigation was whether children would engage in processing patterns that resembled those elicited by adults. Interestingly, despite the presence of considerable group differences (e.g., participant ages, reading ability, memory skills), the processing patterns that emerged from contextual and isolated-word reading were identical across groups.

When interpreting the findings it should be highlighted that the current study used materials suited for use with children in Grade 2. Therefore, although the conclusions drawn here suggest that adults and children engage in comparable semantic and perceptual processes while reading, such similarities may be contingent on whether or not the reading process is successful. Indeed, if children fail or struggle considerably to read words, or if they are unable to understand the meaning of words, then processing differences between children and adults would be expected. In this study, children read *known* words in context and isolation, which led to comparable patterns of processing between groups. This suggests that when children are able to read words correctly, their ability to process words becomes 'adult-like' at a very early stage. Certainly, this provides a novel contribution to the research literature as well as interesting opportunities for ongoing study.

In sum, words read in isolation were processed more based on their perceptual qualities as evidenced by their superior performance on the implicit memory task. Given their preferred status on the explicit memory task, words read in isolation may have also been privy to more semantic processing – however, this result needs to be replicated before firm conclusions can be drawn. But, in either case, the cognitive processes exhibited by children and adults were very similar during both contextual and isolated word reading. And, it appears that the division of labor between semantic and perceptual processing takes on an adult-like quality from a very early age (age 7).

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Appendix A

Target Words

TARGET WORDS

Set 1	Set 2	Set 3	Set 4
Before	Bright	Awful	Branch
Child	Freeze	Breeze	Broke
Forest	Guess	Cannon	Camera
Heart	Maple	Check	Climb
Minute	Nobody	Crack	Moment
Nearby	Professor	Realize	Place
Single	School	Scare	Sticks
Study	Sound	Tiptoe	Teacher
Whistle	Strange	Towards	Under
Young	Tracks	Without	Warning
Average WF/M	**Average WF/M**	**Average WF/M**	**Average WF/M**
198.04	144.97	88.76	134.48
Range	**Range**	**Range**	**Range**
8.33 – 794.14	3.24 – 453.98	0.88 – 354.65	10.08 – 602.67

Note. Average WF/M = Average word frequency per million words.

Appendix B

Story: *My First Class* (Set 1)

My First Class (Set 1)

"No, I can't go, I just can't!!" I cried. My mother demanded to know why I was being such a difficult **child**.

"Freeze right this **minute**!" she cried as I slipped out of her grasp. "Come here!!"

I couldn't sit still for a **single** second. It was my first day at a new school. Was I ever nervous! Suddenly everything about this strange and unknown town struck me again. I wouldn't know any of the other kids like I always had in my old school. I tried to be brave but my **heart** was still beating wildly. Then my mom told me I was a bright **child** and she knew I would be fine. Then she rushed me out the front door, she was in a hurry to get to her job as a professor at a local university.

We began to walk from our house down the **forest** tracks. We often played in the huge **forest**. One day we ventured down the tracks and discovered they went to our new classroom. Today the sound of the woods didn't comfort me as it usually did. I did not notice the wind **whistle** in the trees or the song that a **young** bird in a maple above was chirping. The bird **nearby** was the only sound as we walked through the woods. Maybe nobody would want to be my friend!

Before leaving, we had ventured an estimate of how long it was going to take us to get to class. Our guess was good because we were just on time. Seeing all those kids in my new classroom made me freeze with fear for an instant. The class began. Nobody made a noise as the unknown teacher called out our names. Many of the kids seemed nervous; I guess I wasn't the only new kid. If fact, most of the kids seemed no different than the kids at home!

I discovered that my **heart** had quieted its loud beating. Our teacher was very kind. She smiled at each of us as we answered, "here", when our name was called. Next she made us estimate things we were good at and what we had more trouble with. I had written something about languages because I often found them difficult. A girl next to me tried to take what I had written but luckily a clever **young** boy stopped her. He said her name was Suzie and that his was Dave. He said Suzie always did those things to get attention.

Our teacher kept us busy all day. We read a book called "The Professor and his Dog". It was strange but very funny. We also had to **study** a song and learn the words. We did have to **study** languages but I didn't mind, for once it was fun!! **Before** I knew it there was only one **minute** left. My clever new friend, Dave, told me he lived **nearby**. As we were leaving he said to come over if I ever wanted to play.

"That seems like fun," I answered happily.

We lined up **single** file and had to walk slowly down the hall. Soon I was walking home with my brother, whose day had been as good as mine. I looked at the blackbird chirping in the maple above and smiled a bright smile. I realized I had started to **whistle** a happy tune as well. I confessed to myself maybe everything was going to be alright in this new town after all.

Appendix C

Story: *My First Class* (Set 2)

My First Class (Set 2)

"No, I can't go, I just can't!!" I cried. My mother demanded to know why I was being such a difficult child.

"**Freeze** right this minute!" she cried as I slipped out of her grasp. "Come here!!"

I couldn't sit still for a single second. It was my first day at a new **school**. Was I ever nervous! Suddenly everything about this **strange** and unknown town struck me again. I wouldn't know any of the other kids like I always had in my old **school**. I tried to be brave but my heart was still beating wildly. Then my mom told me I was a **bright** child and she knew I would be fine. Then she rushed me out the front door, she was in a hurry to get to her job as a **professor** at a local university.

We began to walk from our house down the forest **tracks**. We often played in the huge forest. One day we ventured down the **tracks** and discovered they went to our new classroom. Today the **sound** of the woods didn't comfort me as it usually did. I did not notice the wind whistle in the trees or the song that a young bird in a **maple** above was chirping. The bird nearby was the only **sound** as we walked through the woods. Maybe **nobody** would want to be my friend!

Before leaving, we had ventured an estimate of how long it was going to take us to get to class. Our **guess** was good because we were just on time. Seeing all those kids in my new classroom made me **freeze** with fear for an instant. The class began. **Nobody** made a noise as the unknown teacher called out our names. Many of the kids seemed nervous; I **guess** I wasn't the only new kid. In fact, most of the kids seemed no different than the kids at home!

I discovered that my heart had quieted its loud beating. Our teacher was very kind. She smiled at each of us as we answered, "here", when our name was called. Next she made us estimate things we were good at and what we had more trouble with. I had written something about languages because I often found them difficult. A girl next to me tried to take what I had written but luckily a clever young boy stopped her. He said her name was Suzie and that his was Dave. He said Suzie always did those things to get attention.

Our teacher kept us busy all day. We read a book called "The **Professor** and his Dog". It was **strange** but very funny. We also had to study a song and learn the words. We did have to study languages but I didn't mind, for once it was fun!! Before I knew it there was only one minute left. My clever new friend, Dave, told me he lived nearby. As we were leaving he said to come over if I ever wanted to play.

"That seems like fun," I answered happily.

We lined up single file and had to walk slowly down the hall. Soon I was walking home with my brother, whose day had been as good as mine. I looked at the blackbird chirping in the **maple** above and smiled a **bright** smile. I realized I had started to whistle a happy tune as well. I confessed to myself maybe everything was going to be alright in this new town after all.

Appendix D

Story: *Halloween* (Set 3)

***The Halloween Story** (Set 3)*

It was Halloween and the kids in grade four were creating a haunted house. Their room was made into a small wooded area. The kids placed some leaves and dead sticks on the floor to make the woods look more real. Miss Mayer, the teacher, decided that because it was such a good haunted house, they could invite the older children to **check** it out. The grade fours couldn't wait!

"I think we're just about ready," the teacher said while she helped some kids climb into costumes, "but we better hurry!"

When it was time, the grade five children filed in the back of the room. A few were giggling and looked like they were going to **crack** up. A small sign was at the beginning of the woods, it read "WARNING – KEEP OUT!" The older kids just grinned at the sign. Not much would **scare** these kids!

"We mustn't make a noise, be sure to **tiptoe** as quietly as mice," Miss Mayer told the children.

The only noise the kids heard was a branch in the **breeze** tapping on the window. The older children's feet crunched on the dead sticks.

"Look!" whispered one student looking at the owl's nest, "I think I see something!"

Without warning the noise of the branch in the **breeze** was replaced by a loud **CRACK**. The children gasped as a pretend crow dove down **towards** the heads of the older students from a place high above. A grade five boy did not **realize** when the crow fluttered against him and so he yelled. The next moment, the grade fours returned from the place they had been sitting and ran by flapping long costume wings up and down.

The older children had stopped giggling now as they were getting a little nervous. The older kids made the climb one foot at a time. They looked around a moment later as an **awful** noise broke the silence. It sounded like **cannon** shots. At the same time, a light flashed. It was as bright as a camera! Some of the children yelled as an **awful** crow's screeching was heard. Then the screeching stopped and the children again moved forward. The older kids didn't **realize** but some of the younger kids had been sitting under some desks. These kids now slid as softly as mice and made sure to **tiptoe** around the edge of the desks **without** being seen. Next, the silent children caught up to the older students and jumped around them. The bigger kids were getting really frightened and couldn't take anymore. It was time to escape the **cannon** shots, camera flashes, and the flapping and diving of the crow. The kids fell over each other to try to get away.

"HELP!!" some of the students called. The kids all tried to hurry **towards** the door. Everyone stopped as something caught their eye. The lights went up. It was only the school janitor! Everyone laughed. The old bald janitor tipped the cap on his head with one thumb looped under his belt. He walked away as he said, "Take care, children."

"We sure gave you a **scare**!" the grade fours said and broke into laughter.

The kids all grinned and decided it *was* a good haunted house. Everyone was glad they had come to **check** it out because they had enjoyed themselves very much.

Appendix E

Story: *Halloween* (Set 4)

The Halloween Story (Set 4)

It was Halloween and the kids in grade four were creating a haunted house. Their room was made into a small wooded area. The kids placed some leaves and dead **sticks** on the floor to make the woods look more real. Miss Mayer, the **teacher**, decided that because it was such a good haunted house, they could invite the older children to check it out. The grade fours couldn't wait!

"I think we're just about ready," the **teacher** said while she helped some kids **climb** into costumes, "but we better hurry!"

When it was time, the grade five children filed in the back of the room. A few were giggling and looked like they were going to crack up. A small sign was at the beginning of the woods, it read "**WARNING** – KEEP OUT!" The older kids just grinned at the sign. Not much would scare these kids!

"We mustn't make a noise, be sure to tiptoe as quietly as mice," Miss Mayer told the children.

The only noise the kids heard was a **branch** in the breeze tapping on the window. The older children's feet crunched on the dead **sticks**.

"Look!" whispered one student looking at the owl's nest, "I think I see something!"

Without **warning** the noise of the **branch** in the breeze was replaced by a loud CRACK. The children gasped as a pretend crow dove down towards the heads of the older students from a **place** high above. A grade five boy did not realize when the crow fluttered against him and so he yelled. The next **moment**, the grade fours returned from the **place** they had been sitting and ran by flapping long costume wings up and down.

The older children had stopped giggling now as they were getting a little nervous. The older kids made the **climb** one foot at a time. They looked around a **moment** later as an awful noise **broke** the silence. It sounded like cannon shots. At the same time, a light flashed. It was as bright as a **camera**! Some of the children yelled as an awful crow's screeching was heard. Then the screeching stopped and the children again moved forward. The older kids didn't realize but some of the younger kids had been sitting **under** some desks. These kids now slid as softly as mice and made sure to tiptoe around the edge of the desks without being seen. Next, the silent children caught up to the older students and jumped around them. The bigger kids were getting really frightened and couldn't take anymore. It was time to escape the cannon shots, **camera** flashes, and the flapping and diving of the crow. The kids fell over each other to try to get away.

"HELP!!" some of the students called. The kids all tried to hurry towards the door. Everyone stopped as something caught their eye. The lights went up. It was only the school janitor! Everyone laughed. The old bald janitor tipped the cap on his head with one thumb looped **under** his belt. He walked away as he said, "Take care, children."

"We sure gave you a scare!" the grade fours said and **broke** into laughter.

The kids all grinned and decided it *was* a good haunted house. Everyone was glad they had come to check it out because they had enjoyed themselves very much.

Appendix F

Counterbalance

Participant	WRAT-3	Task One	Second Two	Explicit Memory	WJ-III	Implicit Memory
1	WRAT	*Context* (FC) - Set 1	*Isolation* - Set 3	Free Recall	Number Reverse	**A** (Set 1, 3, & 4)
2	WRAT	*Context* (FC) - Set 1	*Isolation* - Set 4	Free Recall	Number Reverse	**A** (Set 1, 4, & 3)
3	WRAT	*Isolation* - Set 3	*Context* (FC) - Set 1	Free Recall	Number Reverse	**A** (Set 1, 3, & 4)
4	WRAT	*Isolation* - Set 4	*Context* (FC) - Set 1	Free Recall	Number Reverse	**A** (Set 1, 4, & 3)
5	WRAT	*Context* (FC) - Set 2	*Isolation* - Set 3	Free Recall	Number Reverse	**B** (Set 2, 3, & 4)
6	WRAT	*Context* (FC) - Set 2	*Isolation* - Set 4	Free Recall	Number Reverse	**B** (Set 2, 4, & 3)
7	WRAT	*Isolation* - Set 3	*Context* (FC) - Set 2	Free Recall	Number Reverse	**B** (Set 2, 3, & 4)
8	WRAT	*Isolation* - Set 4	*Context* (FC) - Set 2	Free Recall	Number Reverse	**B** (Set 2, 4, & 3)
9	WRAT	*Context* (H) - Set 3	*Isolation* - Set 1	Free Recall	Number Reverse	**C** (Set 3, 1, & 2)
10	WRAT	*Context* (H) - Set 3	*Isolation* - Set 2	Free Recall	Number Reverse	**C** (Set 3, 2, & 1)
11	WRAT	*Isolation* - Set 1	*Context* (H) - Set 3	Free Recall	Number Reverse	**C** (Set 3, 1, & 2)
12	WRAT	*Isolation* - Set 2	*Context* (H) - Set 3	Free Recall	Number Reverse	**C** (Set 3, 2, & 1)
13	WRAT	*Context* (H) - Set 4	*Isolation* - Set 1	Free Recall	Number Reverse	**D** (Set 4, 1, & 2)
14	WRAT	*Context* (H) - Set 4	*Isolation* - Set 2	Free Recall	Number Reverse	**D** (Set 4, 2, & 1)
15	WRAT	*Isolation* - Set 1	*Context* (H) - Set 4	Free Recall	Number Reverse	**D** (Set 4, 1, & 2)
16	WRAT	*Isolation* - Set 2	*Context* (H) - Set 4	Free Recall	Number Reverse	**D** (Set 4, 2, & 1)

Note. WRAT-3

Appendix G

Certification of Ethical Acceptability

UNIVERSITÉ Concordia UNIVERSITY

CERTIFICATION OF ETHICAL ACCEPTABILITY FOR RESEARCH INVOLVING HUMAN SUBJECTS

Name of Applicant:	Dr. Sandra Martin-Chang
Department:	Education
Agency:	FQRSC
Title of Project:	How do Children Process Words in Stories: Differential Semantic and Perceptual processing of Words Read in Context and Isolation
Certification Number:	UH2010-034
Valid From: May 11, 2010	to: May 11, 2011

The members of the University Human Research Ethics Committee have examined the application for a grant to support the above-named project, and consider the experimental procedures, as outlined by the applicant, to be acceptable on ethical grounds for research involving human subjects.

Dr. James Pfaus, Chair, University Human Research Ethics Committee

01/29/2009

Appendix H

Consent Forms

UNIVERSITÉ Concordia UNIVERSITY

Dear Parents and Guardians

My name is Sandra Martin-Chang. I am a professor in the Department of Education at Concordia University. The Lester B. Pearson School Board has given me permission to conduct a reading study in many of its elementary schools. I have already studied many children in Nova Scotia, New Brunswick, and Ontario. I am excited to continue my work with children from Montreal. I will be working with students between the ages of 7 and 14 years old to investigate the best methods of teaching children to read.

If you return this form, your child will be asked to complete an easy reading task lasting no longer than 5 minutes. Some words will be very familiar to your child while others will new. Each child will be given a colourful sticker to thank them for participating. A sub-selection of children will also work one on one with a member of my lab for one extra session (either myself, or a graduate student working under my direct supervision). During the session, students will be asked to read words from a short story and to read words from a computer screen. They will also play a memory game as well as a number game (e.g., repeating numbers backwards). These tasks will last about 20 minutes. There are no likely risks associated with this study.

I expect the children to enjoy their time in the study. I will thank them for their efforts by giving them stickers, sports cards, or pencils at the end of the session. However, your child is free to stop participating in the study at any time if he or she wishes to do so. If you have any questions or concerns, please call me at 514-848-2424, Ext 8932.

All sessions will be scheduled at the teacher's convenience. Testing will be held in a room in the school. All information about individual children will be kept strictly private. Only summary results from all participants will be shared with the schools. These results may be published for professional use. Individual scores will not be given to the schools or parents. At the end of the study, I will prepare a newsletter to the schools and the parents.

It is my hope that your child will benefit from his or her individual time reading with a member from my lab. In addition to the personal reading gains experienced by your child, he or she will also be adding to our understanding of how reading develops in children. The findings that come from such studies are influential in the creation of reading programs. As such, your child's involvement would be extremely appreciated!

With many thanks,

Sandra Martin-Chang, Ph.D.
Department of Education
Concordia University
Office Location: LB 505-7
smartinc@education.concordia.ca
(514) 848-2424 x8932

CONSENT TO PARTICIPATE IN A READING STUDY:
INVESTIGATING LITERACY PROCESSES

This program of research is being conducted by Dr. Sandra Martin-Chang of the Department of Education at Concordia University. She may be reached by phone (514) 848-2424 x8932, or email at smartinc@education.concordia.ca.

A. PURPOSE

I have been informed that the purpose of the research is to investigate the best methods of teaching children to read.

B. PROCEDURES

I understand that my child will be working individually with a member of Dr. Martin-Chang's lab and that he or she will be reading English words in stories and lists.

C. RISKS AND BENEFITS

There are no risks associated with this study. The potential benefits include: a) having my child practice reading words in English, b) having my child work one-on-one with a trained graduate student from the Department of Education at Concordia University, c) adding to the scientific understanding of how reading develops in children.

D. CONDITIONS OF PARTICIPATION

I understand that my child is free to withdraw and discontinue participation at anytime without negative consequences. I understand that my child's data will be kept strictly confidential and that his or her individual scores will not be analyzed or released. I understand that the group data from this study may be published.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOLUNTARILY AGREE TO HAVE MY CHILD PARTICIPATE IN THIS STUDY

Name of Parent ______________________ Signature of parent ____________________
(please print)

Name of Child (please print) ______________________________

Age of Child _________ Birth date of Child ___________________
Day/Month/Year

Verbal Consent from Child *(to be obtained by researcher prior to commencement of study).* ☐

If at any time you have questions about your rights as a research participant, please contact Brigitte des Rosiers, Research Ethics and Compliance Officer, Concordia University, at (514) 848-2424 x7481, or by email at bdesrosi@alcor.concordia.ca.

UNIVERSITÉ Concordia UNIVERSITY

Dear Parents and Guardians

My name is Sandra Martin-Chang. I am a professor in the Department of Education at Concordia University. The University Human Research Ethics Committee has given me permission to conduct a reading study with students between the ages of 7 and 14 years old. This research will investigate the best methods of teaching children to read. I have already studied many children in Nova Scotia, New Brunswick, and Ontario. I am excited to continue my work with children from Montreal.

If you return this form, your child will be asked to complete a few simple reading tasks. These tasks will last no longer than 25 minutes. During the session, your child will work one on one with a member of my lab (either myself, or a graduate student working under my direct supervision). He or she will be asked to complete a series of tasks such as reading words from a short story and reading words from a computer screen. Your child will also complete some memory activities and a "numbers reversed" games. There are no likely risks associated with this study.

I expect the children to enjoy their time in the study. I will also thank them for their efforts by offering them a gift (e.g., book of their choice) at the end of the session. However, your child is free to stop participating at any time if he or she wishes to do so. If you have any questions or concerns, please call me at 514-848-2424, Ext 8932.

All sessions will be scheduled at the parents/caregivers' convenience. All information about individual children will be kept strictly private. Group information will be used for research purposes only and may be published for professional use. Individual scores will not be given to the schools or parents. Only summary results from the group of participants will be shared; at the end of the study, I will prepare a newsletter to the parents.

It is my hope that your child will enjoy and benefit from his or her individual time reading with a member from my lab. In addition, your child will also be adding to our understanding of how reading develops in children. The findings that come from such studies are important in the creation of reading programs. Your child's involvement would be extremely appreciated!

With many thanks,

Sandra Martin-Chang, Ph.D.
Department of Education
Concordia University
Office Location: LB 505-7
smartinc@education.concordia.ca
(514) 848-2424 x8932

CONSENT TO PARTICIPATE IN A READING STUDY:
INVESTIGATING LITERACY PROCESSES

This program of research is being conducted by Dr. Sandra Martin-Chang of the Department of Education at Concordia University. She may be reached by phone (514) 848-2424 x8932, or email at smartinc@education.concordia.ca.

A. PURPOSE

I have been informed that the purpose of the research is to investigate the best methods of teaching children to read.

B. PROCEDURES

I understand that my child will be working individually with a member of Dr. Martin-Chang's lab and that he or she will be reading English words in stories and lists.

C. RISKS AND BENEFITS

There are no risks associated with this study. The potential benefits include: a) having my child practice reading words in English, b) having my child work one-on-one with a trained graduate student from the Department of Education at Concordia University, c) adding to the scientific understanding of how reading develops in children.

D. CONDITIONS OF PARTICIPATION

I understand that my child is free to withdraw and discontinue participation at anytime without negative consequences. I understand that my child's data will be kept strictly confidential and that his or her individual scores will not be analyzed or released. I understand that the group data from this study may be published.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOLUNTARILY AGREE TO HAVE MY CHILD PARTICIPATE IN THIS STUDY

Name of Parent ______________________ Signature of parent ______________________
(please print)

Name of Child (please print) ________________________________

Signature of Child Participant ________________________________

Age of Child ____________ Birth date of Child ________________
Day/Month/Year

If at any time you have questions about your rights as a research participant, please contact Brigitte des Rosiers, Research Ethics and Compliance Officer, Concordia University, at (514) 848-2424 x7481, or by email at bdesrosi@alcor.concordia.ca.

CONSENT TO PARTICIPATE IN:
INVESTIGATING LITERACY PROCESSES

This is to state that I agree to participate in a program of research being conducted by Dr. Sandra Martin-Chang of the Department of Education at Concordia University. She may be reached by phone (514) 848-2424 x8932, or email at smartinc@education.concordia.ca.

A. PURPOSE

I have been informed that the purpose of the research is to investigate the best methods of teaching children to read.

B. PROCEDURES

I understand that I will be working individually with a member of Dr. Martin-Chang's lab and that I will be reading English words in stories and lists. The tasks will take approximately 20-25 minutes to complete. I understand that my answers will be confidential, and will not be associated with any identifying information beyond this point. Data will be kept in a locked room at all times, and will be destroyed after a period of five years. Only group data from this project will be published.

C. RISKS AND BENEFITS

I have been informed that there is minimal risk to my involvement in this study. On the contrary, the researchers hope that I will directly benefit from my participation by learning about the types of research techniques that can be used with young people. Upon completion of the session, I will receive a small stipend in the amount of $10.00.

D. CONDITIONS OF PARTICIPATION

- I understand that I am free to withdraw my consent and discontinue my participation at any time without negative consequences whatsoever.
- I understand that my participation in this study is confidential.
- I understand that the data in this study may be published.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOLUNTARILY AGREE TO PARTICIPATE IN THIS STUDY.

NAME (please print): ____

SIGNATURE: ____

If at any time you have questions about your rights as a research participant, please contact Brigitte des Rosiers, Research Ethics and Compliance Officer, Concordia University, at (514) 848-2424 x7481, or by email at bdesrosi@alcor.concordia.ca.