Verb Aspect and World Knowledge in the Mental Representation of Text:

Evidence from Eye Movements

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2010

Abstract

Reading involves the dynamic construction of a mental model corresponding to the situation described in a text. This representation draws on the semantic and grammatical content of the text and also involves inferences for unstated information and the sequencing of events in time. In the current study, an eye-tracking methodology was used to explore the critical role of grammatical aspect in this process. The results showed that, following an event expressed in imperfective aspect, the reading of a necessarily later event was slowed compared to when the earlier event was expressed in perfective aspect. However, the effect depended on world knowledge—when the first event was typically of short duration, it did not evoke an "ongoing" interpretation to the same degree compared to when it was of long duration. The results highlight comprehenders' use of world knowledge and subtle grammatical cues in the representation of event information during on-line reading.
Acknowledgments

I owe my deepest gratitude to my supervisors Meredyth Daneman and Craig Chambers for their continuous encouragement, guidance, and assistance throughout my work on this project. I would also like to thank Eyal Reingold for his invaluable advice.

Lastly, I offer my regards to my family and friends who inspired and supported me during the completion of the project.
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Verb Aspect and World Knowledge in the Mental Representation of Text:
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Consider the following passage:

(1) Dr. Sullivan was a long-time member of the hospital surgical team. He was operating on Mrs. Jones to remove a tumour. Dr. Sullivan dropped by the waiting room to let the family know that the procedure was over. Once again everyone acknowledged his incredible surgical skills.

Were you surprised to encounter the phrase “Dr. Sullivan dropped by the waiting room” after having just read that the surgeon “was operating on Mrs. Jones to remove a tumour”? Would it have been any easier to read the text had it been presented in the following form?

(2) Dr. Sullivan was a long-time member of the hospital surgical team. He operated on Mrs. Jones to remove a tumour. Dr. Sullivan dropped by the waiting room to let the family know that the procedure was over. Once again everyone acknowledged his incredible surgical skills.

The typical grammatical purpose of the imperfective aspect (e.g., was operating on) is to refer to an event that is ongoing or uncompleted. In contrast, the typical goal of the perfective aspect (e.g., operated on) is to signify that an event is completed. Thus, (1) should appear somewhat more “odd” than (2) because, in terms of grammar, the boundaries of two consecutive events (e.g., surgery on Mrs. Jones and the doctor's conversation with her relatives) are more clearly expressed in the second passage. In the present study, I used an eye-tracking methodology to investigate readers' sensitivity to these grammatically-evoked differences. In particular, I explored whether readers have more difficulty processing text that describes a situation that would occur only after the completion of the previously described event (e.g., a surgeon dropping by the waiting room after operating on a tumour) when the first event is described in an imperfective aspect rather than a perfective aspect.
According to previous research, reading sentences with imperfective versus perfective aspect requires the construction of different mental representations (Carreiras, Carriedo, Alonso, & Fernandez, 1997; Ferretti, Kutas, & McRae, 2007; Ferretti, Rohde, Kehler, & Crutchley, 2009; Madden & Therriault, 2009; Madden & Zwaan, 2003; Magliano & Schleich, 2000; Morrow, 1990; Truitt & Zwaan, 1997). However, a core question in reading research is the degree to which the content of these mental representations is specified and whether the construction and integration of information in these models occurs incrementally while reading. The potential difference in reading patterns for passages in (1) and (2) present an interesting and highly relevant test case for these issues because the aspect contrast is comparatively subtle. That is, the passage in (1) does not present an actual anomaly in which text information is outright incompatible with previously read material, which is a common way to test for the content of mental representations in text reading research. The passage in (1) simply requires the reader to make an additional bridging inference, namely that the previously described event (operating on a tumour) had in fact been completed. However, making a bridging inference should add to processing time (e.g., Keenan & Kintsch, 1974; Singer, Andrusiak, Reisdorf, & Black, 1992). Consequently, if readers encode aspect when initially encountering the verb, they should take longer to process the phrase “Dr. Sullivan dropped by the waiting room…” when it follows the imperfective “He was operating on…” sentence compared to the perfective “He operated on…” sentence. By monitoring readers’ eye movements for spontaneous disruptions when encountering target phrases such as dropped by the waiting room, my study investigated whether readers encode verb aspect into their mental representations as they read, and whether a reader’s comprehension skill and age impact on the online encoding of verb aspect.
In the following sections, I provide a more detailed overview of research on the processing of aspect information as well as an overview of potentially relevant research on reading skill and aging effects in text comprehension. I then turn to a more detailed description of the current experiment.

**Previous Studies of Verb Aspect**

A number of studies have demonstrated that verb aspect is an important source of information about the state and internal structure of a described event (Carreiras et al., 1997; Ferretti et al., 2007; Ferretti et al., 2009; Madden & Therriault, 2009; Madden & Zwaan, 2003; Magliano & Schleich, 2000; Morrow, 1990; Truitt & Zwaan, 1997). Morrow (1990) asked participants to read sentences conveying a character moving from one location to another in a house (e.g., “John was walking/walked through the kitchen toward the bedroom”). When the movement of a character was described in an imperfective aspect, participants were more likely to indicate on the house diagram that a character is somewhere between the two locations (e.g., kitchen). However, after reading the description in a perfective aspect, participants were more likely to assume that a character is in the second location (e.g., bedroom). In another study, when participants had to choose which picture better describes a just read sentence, they preferred the image that depicted the event as completed rather than the one that depicted the event as ongoing after reading the description of the event in the perfective aspect. However, participants did not exhibit a preference for a particular picture when the imperfective aspect was used to describe the same event (Madden & Zwaan, 2003). Furthermore, verb phrases in the imperfective aspect (e.g., was pounding a nail) are more likely to prime words that refer to the typical instruments such as “hammer” (Truitt & Zwaan, 1997) and, as indicated by studies using a short stimulus onset asynchrony semantic priming task, locations such as “construction site” (Ferretti et al.,
2007) compared with verbs in the perfective aspect (e.g., *pounded a nail*). Thus, grammatical markers such as verb aspect play an important role in guiding our mental representations of a given phrase or sentence.

More relevant for the current study is work examining the interpretation of a sequence of events in connected discourse, and how aspect information influences this process. A study by Magliano and Schleich (2000) investigated the impact of verb aspect on text representation using various off-line measures. The authors showed that readers are more likely to perceive activities as ongoing in subsequent context when the activities are described in an imperfective aspect rather than in a perfective aspect. Magliano and Schleich gave their participants stories similar to the following one:

Jack’s wife Betty was expecting a baby, and boy was he excited. He was planning to be her coach when she gave birth. He went to all the Lamaze classes. Every night, Jack made Betty practice her breathing. Finally, the big night was here. Betty was delivering/delivered their first child. Jack fainted dead on the spot. The video recorder went crashing to the ground. A nurse had to stop what she was doing and help Jack. Jack recorded about 10 seconds of the birth of their child. He was never more embarrassed in his life.

The readers were interrupted either immediately, or one, two or three sentences after the aspect sentence (e.g., “Betty was delivering/delivered their first child”) with a critical test question such as “Has the baby been born yet?”. The participants were more likely to answer “no” when the event was described in an imperfective aspect (e.g., *was delivering*) than when it was described in a perfective aspect (e.g., *delivered*). The effect remained at all probe question positions, although it decreased as the number of subsequent sentences increased. In a second experiment, Magliano and Schleich extended these findings by demonstrating that relatively long events (e.g., surgery) are more likely to be perceived as ongoing compared to relatively short events (e.g., 100 m race) as the number of intervening sentences between an aspect sentence and a
probe question increases. The authors concluded that readers are sensitive to both world and grammar knowledge when constructing mental representations of a text during reading.

In a third and fourth experiment, Magliano and Schleich (2000) investigated the relationship between aspect processing and the reader’s working memory capacity by determining the overall activation level of an aspect event over time. The task was to identify as quickly as possible whether a verb phrase (e.g., deliver baby) referring to the event described in the aspect sentence (e.g., “Betty delivered/was delivering their first child”) occurred in one of the previous sentences. The authors observed no differences between low-span and high-span readers’ response latencies when the verb phrase was presented immediately after the aspect sentence. However, only the high-span readers were faster for the in-progress/imperfective versions compared to the completed/perfective versions when the verb phrase was presented after three intervening sentences following the aspect sentence. The authors attributed this finding to the ability of high-span readers to tag imperfective aspect information as salient and maintain it in working memory as the sequence of described events unfolded.

Although the above-mentioned studies have provided interesting insights into the processing of verb aspect, they cannot establish the degree to which aspect affects situation model construction in an on-line manner and in a more naturalistic reading task that does not call explicit attention to the status of events. Recall that in the studies described above, participants were required to verify whether a picture was described in a previous sentence (Madden & Zwaan, 2003), to name a word after a prime (Ferretti et al., 2007), or to answer questions about a state of events when interrupted while reading a story (Magliano & Schleich, 2000). First of all, it is unclear how constant interruptions of reading with probe questions would affect verb aspect information processing. In addition, responses to explicit probe questions may simply reflect
readers’ speed and ability to retrieve previously encountered text information for their responses rather than their spontaneous construction of mental representations during reading. As noted by Baggio, van Lambalgen, and Hagoort (2008), it can be argued that readers may have drawn the particular inferences in order to facilitate a response at the time the probes were presented, but would have processed the same sentences in a different manner had the secondary response not been required. In other words, post-reading responses may provide very limited information regarding the time course of aspect effects on the construction of mental representations of text during normal reading. Hence, the goal of the present study was to explore these factors using a task that demands nothing other than normal reading for comprehension.

**Verb Aspect and Comprehension Skill**

One of the main issues in research on individual differences in reading comprehension is the identification of component processes that underlie these differences. The ability to construct mental representations of text has been a topic of substantial interest in the scientific community in explanations for the variability among individuals in reading comprehension. According to this research, less-skilled comprehenders construct less complete and less accurate mental representations of text than do skilled comprehenders (e.g., Daneman, Lennertz, & Hannon, 2007; Hannon & Daneman, 2004; Long, Oppy, & Seely, 1997; Zwaan & Brown, 1996).

For example, Hannon and Daneman (2004) used Barton and Sanford’s (1993) anomaly detection task to investigate processing style differences between skilled and less-skilled adult readers. Participants read passages such as the following:

There was a tourist flight traveling from Vienna to Barcelona. On the last leg of the journey, it developed engine trouble. Over the Pyrenees, the pilot started to lose control. The plane eventually crashed right on the border. Wreckage was equally strewn in France and Spain. The authorities were trying to decide where to bury the survivors/surviving injured/surviving dead (Barton & Sanford, p. 479).
Hannon and Daneman found that less-skilled readers had particular difficulty noticing semantically anomalous phrases such as *surviving dead* compared to skilled readers (see also Daneman et al., 2007). Hannon and Daneman interpreted these results as an indication that less-skilled readers are more susceptible to partial or incomplete semantic processing than are skilled readers. In addition, less-skilled readers seem to have particular difficulty in detecting semantic anomalies when the break in coherence is separated by intervening text (Long & Chong, 2001). If these findings generalize to syntactic processing, then one might expect that less skilled comprehenders would be less sensitive to the subtle imperfective/perfective manipulation used in the current study.

Although there is evidence to suggest that readers engage in shallow processing at the level of *syntactic* analysis (e.g., Christianson, Ferreira, & Hollingworth, 2001; see Ferreira & Patson, 2007 for a review), the evidence regarding the impact of reading comprehension skill on these processes is less clear (Kemper, Crow, & Kemtes, 2004; Magliano & Schleich, 2000). For example, Christianson et al. (2001) presented readers with garden-path sentences such as “While Anna dressed the baby played in the crib.” Readers are led down the garden-path because they initially interpret *the baby* to be the object of *dressed*; however, eventually they must reinterpret the sentence in order to arrive at the correct interpretation that *the baby* is the subject of the main clause (e.g., “The baby played in the crib”). In order to assess the final syntactic interpretation of the sentence held by readers, Christianson et al. asked their participants questions such as “Did Anna dress the baby?” and “Did the baby play in the crib?” Although most readers correctly answered that the baby played in the crib, more than half of the readers incorrectly believed that Anna also dressed the baby. Thus, although readers reinterpret the sentence correctly, many maintain the initial incorrect interpretation as well. Christianson and colleagues concluded that
comprehenders construct syntactic representations of text that are “good enough” for understanding, but not necessarily exhaustive. Although Christianson and colleagues did not investigate reading skill differences in their task, Kemper et al. (2004) compared readers with high and low working memory spans on sentences containing similar temporary syntactic ambiguities (e.g., “The experienced soldiers warned about the dangers conducted the midnight raid.”). On the one hand, Kemper et al.’s eye-movement data (e.g., fixation time and number of regressions) revealed that low-span and high-span readers were equally disrupted by the ambiguous regions of the sentences, a finding that suggests that the low-span (less-skilled) readers attempted to process the text as thoroughly as did the high-span (more skilled) readers. On the other hand, responses to a probe question (e.g., “Who warned about the dangers?”) revealed that low-span readers were much more likely to provide an incorrect answer (e.g., soldiers) as compared to high-span readers (45% vs. 14%), a finding that suggests that the low-span readers were less successful at recomputing/resolving the complex syntactic structures. Of course, these temporary syntactic ambiguities involve more complex parsing and resolution processes than do the imperfective/perfective constructions (e.g., *He was operating on/He operated on...*) used in the current study, and so it is difficult to know whether the Kemper et al. findings would generalize to the more subtle imperfective/perfective grammatical markers used in the present experiment. As noted earlier, Magliano and Schleich (2000) did investigate individual differences in verb aspect processing as a function of readers’ working memory spans, and they showed that high-span readers maintain imperfective activities at a high level of activation for a longer duration than do low-span readers. However, their activation paradigm could not directly assess whether there are individual differences in the way skilled and less-skilled readers process imperfective versus perfective verbs when first encountering them.
In the current study, I investigated whether reading comprehension skill impacts on verb aspect processing. As in Hannon and Daneman (2004), reading skill was assessed with the widely used Nelson-Denny test of reading comprehension. Participants who achieved above the median score were classified as skilled readers, whereas participants who scored at or below the median score were classified as less-skilled readers. A possible prediction is that skilled readers might show more disruptions in eye movement behaviour (longer fixation time, more regressions) when reading about a later event (e.g., Dr. Sullivan dropping by the waiting room…) when the necessarily earlier event was expressed using an imperfective vs. perfective verb (e.g., *He was operating on/He operated on…*). In contrast, less-skilled readers might engage in shallower processing than their skilled counterparts, and consequently show no differences in eye movement behaviour during the reading of the target phrase as a function of the aspect marker that preceded it.

**Verb Aspect and Aging**

According to previous research, perceptual and cognitive processing resources decline with normal aging (Baltes, 1997; Salthouse, 1991), whereas linguistic knowledge and world knowledge appear to remain relatively stable or even grow over time (e.g., Baltes, 1997; Kemper & Zelinski, 1994). For example, Dijkstra, Yaxley, Madden, and Zwaan (2004) presented participants with a sentence (e.g., “There was bread in the bakery window/toaster”) and then showed a picture of an object that either matched or mismatched the implied shape of an object in the sentence (e.g., whole loaf of bread vs. one slice). The authors reported a stronger mismatch effect (e.g., slower responses when shown the whole loaf of bread after reading “There was bread in the toaster” than “There was bread in the bakery window”) for older compared to younger adults. Dijkstra and colleagues argued that these results can be explained by the more
vivid and stronger mental representations of text constructed by older adults compared to younger adults. In another study using Barton and Sanford’s (1993) anomaly detection task, Daneman, Hannon, and Burton (2006) found no differences between older and young adults in the ability to detect and report semantically anomalous phrases such as surviving injured and surviving dead; if anything, eye movements showed that older readers were quicker to detect internally coherent anomalies such as (burying the) surviving injured; however, the eye movement patterns also revealed that older readers spent more time making regressive fixations, suggesting that they had to allocate disproportionately more processing resources to achieve comparable levels of detection/resolution success.

The literature on aging and language comprehension suggests that despite declines in speed of processing and working memory capacity, older adults have relatively well preserved syntactic processing abilities (Baum, 1991; Burke & Shafto, 2008; Waters & Caplan, 2005). For example, Waters and Caplan (2005) used the auditory moving window paradigm to investigate the effects of aging, working memory capacity, and speed of processing on online syntactic processing. Waters and Caplan observed that although older participants had significantly lower working memory capacities, they “did not show a disproportionate increase in listening time on the capacity demanding portion of the complex sentence (e.g., ‘It was the child that the movie terrified because it showed a monster’)” (p. 411). Baum (1991) asked her participants to monitor for words signaling ungrammaticality in auditory-presented sentences such as “He shut the window that, much to his surprise, the door was OPEN in the kitchen.” Error and reaction time analyses revealed that older participants, like their younger counterparts, were sensitive to the violations of long-distance dependency constructions. However, Kemper et al. (2004) showed that even though older readers are as sensitive as younger readers to temporary syntactic
ambiguities in sentences such as “The experienced soldiers warned about the dangers conducted the midnight raid”, they made significantly more regressive fixations while reading the ambiguous parts of a sentence. This finding illustrates the usefulness of complementing traditional error and reaction time measures with moment-to-moment eye-tracking measures.

The above-mentioned findings regarding aging effects on semantic and syntactic processing lead to several predictions. First, because older adults spontaneously use grammatical markers and create comparable or even more vivid mental representations of text than do younger adults, they should find a target phrase (e.g., “Dr. Sullivan dropped by the waiting room…”) that demands a revision of the in-progress interpretation of the imperfective aspect (e.g., \textit{He was operating on…}) as problematic as younger adults do. Second, if achieving good comprehension comes at the expense of needing more time and more revisions to process complicated parts of text, then older readers should fixate longer and make more regressive fixations after encountering the problematic target phrase \textit{dropped by the waiting room} in (1) relative to their younger counterparts. To investigate whether aging has an impact on the on-line processing of verb aspect, I compared the eye fixation behaviour of a group of younger adults who were all students at the University of Toronto Mississauga (mean age = 19.44) with a group of older adults from the Mississauga community (mean age = 70.45 years).

\textbf{Overview of Current Study}

In the current study, the task demanded nothing other than normal reading for comprehension. Participants read naturalistic prose passages such as the examples shown above in (1) or (2). The main difference between the two versions was the aspect sentence which described a previous activity as being in progress (using an imperfective verb, e.g., \textit{He was operating in} example (1)) or as completed (using a perfective verb, e.g., \textit{He operated...}). In both
versions, the critical sentence contained a target phrase referring to a new event that always required the action described in the aspect sentence to be understood as completed (e.g., dropped by the waiting room). If the imperfective verb in the earlier sentence triggered an ongoing interpretation of the event or action, then participants would have to make a bridging inference that the previous activity had been completed. Participants were simply instructed to read the passages for comprehension, and their eye movements were monitored for evidence of greater disruption when they encountered the target phrase (e.g., dropped by the waiting room). I predicted that participants would fixate longer on a target phrase and make more regressions to the aspect verb when the target phrase was preceded by an imperfective aspect sentence compared to a perfective aspect sentence.

In addition to the aspect manipulation, I also varied the relative event duration associated with the verbs in the aspect sentence. For example, the passage in (1) represents a case in which the event in the aspect sentence (brain surgery) takes a relatively long time to complete. In contrast, consider the corresponding event in the following passage:

(3) Finally, the horrible day at the office was over. Kathleen was brushing her teeth. She went to bed to get rest before another busy day tomorrow. The weekend seemed so far away.

The aspect sentence in (3) denotes an event that is typically of short duration (brushing one’s teeth). Magliano and Schleich (2000) showed that when their probe question (e.g., Was the tooth brushing complete?) was presented immediately after an imperfective aspect sentence, readers were equally likely to perceive both long and short events as ongoing. However, when additional text intervened between the imperfective aspect sentence and presentation of the probe question, readers were more likely to perceive the long event as still ongoing compared to the short event. Magliano and Schleich’s finding suggests that readers use both world knowledge and verb aspect information when constructing their mental representations of the duration of events in text.
Given their findings, I predicted that readers should have more difficulty revising their in-progress interpretations of a long duration imperfective verb (as in “was operating on Mrs. Jones to remove a brain tumour”) than a short-duration imperfective verb (e.g., “was brushing her teeth”).

Another goal of the present study was to investigate the effects of intervening text on the processing and incorporation of verb aspect information into readers’ mental representations of text. For this purpose, a neutral sentence that did not favor either an ongoing or completed interpretation of the previous event (e.g., “It was his one hundredth surgery.”) was inserted between the aspect sentence and the sentence containing target phrase; see passages in (4) and (5).

(4) Dr. Sullivan was a long-time member of the hospital surgical team. He was operating on Mrs. Jones to remove a tumour. It was his one hundredth surgery. Dr. Sullivan dropped by the waiting room to let the family know that the procedure was over. Once again everyone acknowledged his incredible surgical skills.

(5) Dr. Sullivan was a long-time member of the hospital surgical team. He operated on Mrs. Jones to remove a tumour. It was his one hundredth surgery. Dr. Sullivan dropped by the waiting room to let the family know that the procedure was over. Once again everyone acknowledged his incredible surgical skills.

Magliano and Schleich (2000) showed that as more and more text becomes available after an imperfective aspect sentence, the perception of an event as ongoing starts to fade away. They argued that the activation of the aspect information gradually decreases due to the limits of working memory capacity. In other words, people simply forget previous text information including aspect information as a story unfolds. According to this interpretation, readers should have less trouble processing a target phrase after an imperfective aspect sentence when there is an intervening sentence between the two (e.g., passage 4) compared to when there is no intervening sentence (e.g., passage 1). However, it is also possible that once aspect information
is incorporated into a situation model it does not require substantial cognitive resources to remain a part of that situation model unless contradictory information becomes available (Zwaan & Radvansky, 1998). Yet another possibility is that a neutral intervening sentence allows the interpretation of the previously-mentioned event as ongoing to become more entrenched. If this is the case, readers should have more difficulty accommodating target phrases such as *dropped by the waiting room* when reading the passage in (4) compared to the passage in (1).

The final goal of the current study was to investigate whether the text manipulations of aspect, event duration, and intervening sentences differentially affected readers as a function of their comprehension skill level and their age.

**Method**

**Participants**

The participants were 32 younger adults whose ages ranged from 17 to 30 years (*M* = 19.44 years, *SD* = 2.69) and 32 older adults whose ages ranged from 63 to 83 years (*M* = 70.45 years, *SD* = 5.42). Eight additional participants were discarded because of eye calibration problems and another participant was eliminated because of very poor performance on the Nelson-Denny test (a score of 4 out of 36). The younger participants were recruited from students at the University of Toronto at Mississauga. The older adults were volunteers from the local community in Mississauga, Ontario. All participants were fluent speakers of English and had normal or corrected to normal vision. Participants were paid $10 per hour or received course credit for their participation. All participants were tested individually in one session. Each participant completed the aspect comprehension task, followed by the test of reading comprehension ability. Each session lasted approximately one hour.
Aspect Comprehension Task

Participants read 50 short passages on a computer screen and answered a simple comprehension question after each passage. Thirty-two of the passages were experimental passages, 16 were filler passages included to disguise the aspect manipulation, and 2 were practice passages. Participants’ eye movements were monitored and recorded while reading the text.

Materials and procedure. The experimental materials consisted of 32 short passages. Some of the passages were adapted from Magliano and Schleich (2000), and some were created for the current study. Half of the experimental passages contained an aspect sentence that described a relatively long event (e.g., “He was operating/operated on Mrs. Jones to remove a tumour.”), and the other half contained an aspect sentences that described a relatively short event (e.g., “Kathleen was brushing/brushed her teeth.”); see Table 1 for a list of the 16 long events and 16 short events used in the study and Table 2 for a sample long-duration passage and a sample short-duration passage (see Appendix A for the complete list of experimental passages).
Table 1

*List of Long and Short Duration Events Used in the Experiment*

<table>
<thead>
<tr>
<th>Long duration events</th>
<th>Short duration events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving from Montana to New York.</td>
<td>Packing a suitcase.</td>
</tr>
<tr>
<td>Knitting a sweater.</td>
<td>Changing a flat tire.</td>
</tr>
<tr>
<td>Painting a series of landscapes.</td>
<td>Entering a courtroom.</td>
</tr>
<tr>
<td>Recording a music album.</td>
<td>Writing a personal cheque.</td>
</tr>
<tr>
<td>Watching a movie at the cinema.</td>
<td>Running a heat in the hundred-meter dash.</td>
</tr>
<tr>
<td>Rescuing a boy trapped in a sinking cruise ship.</td>
<td>Doing fifty pushups.</td>
</tr>
<tr>
<td>Operating to remove a tumour.</td>
<td>Taking a shower.</td>
</tr>
<tr>
<td>Flying from Toronto to Vancouver.</td>
<td>Setting a table for a party.</td>
</tr>
<tr>
<td>Serving a three-year prison sentence.</td>
<td>Opening a gift.</td>
</tr>
<tr>
<td>Riding in a 200-km bike race.</td>
<td>Brushing your teeth.</td>
</tr>
<tr>
<td>Shooting a film version of a book.</td>
<td>videotaping a son playing in the park.</td>
</tr>
<tr>
<td>Building a cedar strip canoe.</td>
<td>Picking some tomatoes and lettuce from a garden.</td>
</tr>
<tr>
<td>Sewing a wedding dress.</td>
<td>Landing a plane.</td>
</tr>
<tr>
<td>Performing the lead role of an opera.</td>
<td>Lighting a fire.</td>
</tr>
<tr>
<td>Casting a three-metre tall bronze sculpture.</td>
<td>Making a cup of latte in a coffee shop.</td>
</tr>
<tr>
<td>Giving a three-hour-long lecture.</td>
<td>Cleaning a bruise on a knee.</td>
</tr>
</tbody>
</table>
There were two aspect versions for each passage, one in which an event was described in the imperfective form (e.g., *was operating; was brushing*) and a second in which the event was described in the perfective form (e.g., *operated; brushed*). The critical test sentence encountered later contained a target phrase (e.g., *dropped by the waiting room; went to bed*) referring to a new event that always required the action described in the aspect sentence to be understood as completed (e.g., the surgeon can come to the waiting room only after the surgery is over; Kathleen goes to bed only after completing her tooth brushing). In other words, the two activities could not be concurrent. However, there was no explicit statement that the activity described by the aspect sentence was over. If the imperfective aspect triggers an ongoing interpretation of the event or action and readers attempt to construct a coherent representation of the text, I expected that participants would have to make an inference that the previous activity is already complete upon reading the target phrase. Making this additional inference should result in more cognitive resources required to process the target phrase and be reflected in longer reading times and/or regressions to earlier text regions. A further manipulation involved the extent of *continuity* between the aspect sentence and the target sentence. In the no intervening sentence condition, the sentence containing the target phrase directly followed the aspect sentence; in the intervening sentence condition, the sentence containing the target phrase and the aspect sentence were separated by a single sentence (e.g., “It was his one hundredth surgery” for the surgery passage, “Work occupied her mind to the exclusion of all else” for the brushing teeth passage). The intervening sentence was designed to be neutral and did not favour either an ongoing or completed interpretation of the previous aspect sentence.

Each passage contained 4 to 5 sentences depending on whether it contained the intervening sentence. The first sentence introduced the main character and/or the context of the
event. The two/three experimental sentences followed the introduction. Finally, a concluding sentence finished each passage; see Table 2.

Table 2

*Sample Passages with Two Possible Aspect Sentences (target phrases are in bold)*

<table>
<thead>
<tr>
<th>Passage describing a relatively long event</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction:</strong></td>
</tr>
<tr>
<td><strong>Aspect sentence:</strong></td>
</tr>
<tr>
<td><strong>Intervening sentence:</strong></td>
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<tr>
<td><strong>Sentence with the target phrase:</strong></td>
</tr>
<tr>
<td><strong>Concluding sentence:</strong></td>
</tr>
<tr>
<td><strong>True or false statement:</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Passage describing a relatively short event</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction:</strong></td>
</tr>
<tr>
<td><strong>Aspect sentence:</strong></td>
</tr>
<tr>
<td><strong>Intervening sentence:</strong></td>
</tr>
<tr>
<td><strong>Sentence with the target phrase:</strong></td>
</tr>
<tr>
<td><strong>Concluding sentence:</strong></td>
</tr>
<tr>
<td><strong>True or false statement:</strong></td>
</tr>
</tbody>
</table>

After reading each passage participants had to make a true-or-false decision regarding a statement such as “Dr. Sullivan had just graduated from medical school” or “Kathleen thought the weekend felt far off.” Half of the true/false comprehension statements for the experimental
passages tested for information that appeared in the first sentence of the experimental passage and the other half tested for information that appeared in the last sentence of the story. The true/false comprehension statements for the 16 filler passages always tested for information that appeared in the middle sentences of a passage. For half of the comprehension statements, the correct response was “true” and for the other half, it was “false.” Younger readers answered 96% of the questions correctly and older readers answered 94% of the questions correctly. This high level of performance suggests that readers were indeed processing the passages for meaning.

The four versions of each experimental passage (imperfective--no intervening sentence; imperfective--intervening sentence; perfective--no intervening sentence; perfective--intervening sentence) were assigned to one of four stimulus lists such that each list contained an equal number of passages in each experimental condition. For each list, the 32 experimental passages were randomly interspersed with 16 filler passages with the constraint that there be no more than two passages in the same condition adjacent to one another and that no more than four experimental passages occur in sequence. Participants were randomly assigned to one of the four stimulus files with the constraint that an equal number of younger and older participants were assigned to each of the four stimulus files.

Passages were presented one at a time in double-spaced Arial 24 font on a computer screen. Participants read the passages silently at their own pace. They were instructed to read for comprehension and were told they would be presented a true-or-false question after each passage. After they finished reading, participants pressed a button on the controller and the true-or-false statement appeared on the screen. Participants indicated their response by pressing a
button labeled “true” or “false.” There were two practice trials to familiarize participants with the procedure.

While reading, participants’ eye movements were recorded using an EyeLink II eye tracking system (SR Research Ltd.). This system consists of a headband that contains three small cameras that allow simultaneous tracking of both eyes and head position, making possible the computation of true gaze position with unrestrained head motion. The eye that gave the most precise measures during calibration was used to record gaze position for the reading task. The eye tracker was set to detect saccades with an amplitude of 0.5° or greater, using an acceleration threshold of 9500°/s² and a velocity threshold of 30°/s. The system displays real-time feedback about participant’s eye movements to the experimenter, allowing the experimenter to monitor performance and recalibrate the eye tracking system as necessary.

Reading Comprehension Test

Participants were administered a standardized test of reading comprehension ability (Form E of the Nelson-Denny test: Brown, Bennett, & Hanna, 1981). The Nelson-Denny test consists of eight prose passages and 36 multiple-choice questions. Participants were given 20 minutes to read the passages and answer the questions.

Results and Discussion

Mean performance on the Nelson-Denny test of reading comprehension ability was 22.83 out of 36 ($SD = 5.48$). For younger adults, the mean score was 23.34 ($SD = 4.99$) and for older adults it was 22.31 ($SD = 5.97$), a difference that was not significant ($p > .40$). Based on the median score (23) for the performance of the participants in the current study, 33 participants
were classified as less-skilled readers ($M = 18.76, SD = 4.13$; 15 younger and 18 older adults), and 31 were classified as skilled readers ($M = 27.16, SD = 2.70$; 17 younger and 14 older adults).

To determine whether there was evidence for online encoding of verb aspect, three dependent measures were used. These were: (a) first pass fixation time on the target phrase, (b) probability of look back to the aspect verb, and (c) look back time on the aspect verb. The first-pass reading time on the target phrase was simply the time spent fixating the target phrase when first encountered (before the reader moved on to a subsequent word or looked back at a previous one). First-pass fixation time was used to determine whether the reader had any trouble processing the target phrase when he/she first encountered it, rather than later on (e.g., at the end of the sentence or at the end of the passage). Probability of look back to the aspect verb was the likelihood that the reader returned to look at the aspect verb at any point after starting to read the target phrase. This measure was used to explore whether readers attempted to resolve potential difficulties with the processing of the target phrase by consulting the region of the text that contained the relevant aspect information. Look back fixation time on the aspect verb was the time spent fixating the aspect verb after encountering the target phrase. Like the measure of probability for looks back to the aspect verb, the look-back fixation time also captures the extent to which the earlier aspect information is used to resolve potential difficulties upon encountering the target sentence.

The three dependent measures were each subjected to a mixed–model analysis of variance (ANOVA) with aspect (imperfective vs. perfective), event duration (long vs. short), and continuity (no intervening sentence vs. intervening sentence) as within-subject factors, and age (younger adults vs. older adults) and reading comprehension skill (skilled readers vs. less-skilled readers) as between-subjects factors. Scores more than 3 standard deviations from the condition
mean were excluded from the analyses (2.5% of all data). Because there were no interactions involving age on any of the dependent measures, and because the effects of reading comprehension skill were limited (see discussion below), the eye fixation data presented in Table 3 are collapsed across age and reading comprehension skill. Appendix B provides the complete set of data as a function of age and reading comprehension skill.

As Table 3 shows, the eye fixation data provided strong evidence that aspect information interacts with world knowledge and plays an important role in the mental representation of text during online comprehension. The first pass fixation (first column) demonstrate that readers were slower to process a target phrase (e.g., *dropped by the waiting room*) that followed an imperfective verb (e.g., *was operating on…*) than a perfective verb (e.g., *operated on…*), a finding which suggests that readers encode verb aspect information into their mental representations as they read. As predicted, readers were particularly disrupted by the target phrase when the imperfective verb described a long duration event (e.g., operating to remove a patient’s tumour) rather than a short duration event (e.g., brushing one’s teeth). This suggests that readers have more difficulty reinterpreting an ongoing activity as already complete if that activity usually takes a relatively long time to complete than if it takes a relatively short time to complete. Further, although the overall probability of looking back to the aspect verb after encountering the target phrase was low (see second column), readers were more likely to look back to an imperfective verb than to a perfective verb, providing further evidence that readers spontaneously encode verb aspect into their mental representations of text.
Table 3

Mean Reading Times (in milliseconds) and Mean Probability of Look Backs as a Function of Aspect, Event Duration, and Continuity

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Event Duration</th>
<th>First Pass Time</th>
<th>Probability of Look Back</th>
<th>Look-back Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Imperfective</td>
<td>No intervening sentence</td>
<td>689</td>
<td>215</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>Intervening sentence</td>
<td>745</td>
<td>259</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>714</td>
<td>239</td>
<td>0.14</td>
</tr>
<tr>
<td>Short event</td>
<td>No intervening sentence</td>
<td>535</td>
<td>165</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>Intervening sentence</td>
<td>525</td>
<td>168</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>529</td>
<td>166</td>
<td>0.14</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>622</td>
<td>225</td>
<td>0.14</td>
</tr>
<tr>
<td>Perfective</td>
<td>No intervening sentence</td>
<td>658</td>
<td>220</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Intervening sentence</td>
<td>627</td>
<td>192</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>639</td>
<td>206</td>
<td>0.08</td>
</tr>
<tr>
<td>Short event</td>
<td>No intervening sentence</td>
<td>556</td>
<td>163</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Intervening sentence</td>
<td>493</td>
<td>180</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>524</td>
<td>174</td>
<td>0.07</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>581</td>
<td>199</td>
<td>0.08</td>
</tr>
</tbody>
</table>
First Pass Fixation Time

An analysis of first pass fixation time on the target phrase revealed that readers were indeed slower to process a target phrase when first encountered if the earlier aspect sentence contained an imperfective verb (622 ms) than if it contained a perfective verb (581 ms). The 41 ms difference was statistically significant both by subjects, $F_1(1, 60) = 8.55, MSE = 24,102, p < .01$, and by items, $F_2(1, 30) = 4.93, MSE = 35,969, p < .05$. The finding that readers have more difficulty processing the target phrase after the imperfective aspect rather than after the perfective aspect suggests that they are sensitive to verb aspect online, favouring an ongoing interpretation of the action described by an imperfective verb and a completed interpretation of the action described by a perfective verb. There was a main effect of event duration in both subject and item analyses, $F_1(1, 60) = 86.89, MSE = 32,807, p < .001; F_2(1, 30) = 11.80, MSE = 220,045, p < .01$, respectively. Participants took longer to process target phrases in the long event duration passages (677 ms) relative to the short event duration passages (527 ms). This event duration effect could be attributed, in part, to the less interesting fact that target phrases in the long event duration passages were longer ($M = 4.44$ words) compared to the target phrases in the short event duration passages ($M = 3.63$ words). However, more theoretically interesting was the significant interaction between aspect and event duration, $F_1(1, 60) = 5.96, MSE = 26,533, p < .025$, and $F_2(1, 30) = 6.18, MSE = 35,969, p < .025$ (see Figure 1). This interaction reflects the fact that, for long events, participants were slower to read the target phrase following an imperfective verb (714 ms) compared to a perfective verb (639 ms), $t(63) = 3.56, p < .01$; however, the aspect manipulation did not have this effect when the passages described short events (529 vs. 524 ms for imperfective and perfective conditions, $p > .50$). Presumably, readers have more difficulty accommodating the information that an ongoing event is already complete.
when the real world event usually takes a relatively long time to complete (e.g. operating on a patient’s tumour; watching a movie in a cinema) than when it takes a relatively short time to complete (e.g., brushing one’s teeth; opening a gift). These results are consistent with previous findings obtained by Magliano and Schleich (2000) showing that readers use both world knowledge and verb aspect information when constructing and updating their situation models.

![Figure 1](image.png)

*Figure 1.* First pass fixation time on the target phrase as a function of event duration (long vs. short) and aspect (imperfective vs. perfective).

Note: Error bars represent SEs.

The ANOVA conducted on first pass fixation times produced one additional significant interaction, namely that between aspect and continuity. The interaction was marginally significant in the subject analysis, $F_1(1, 60) = 3.95, MSE = 32,414, p = .051$, and highly significant in the item analysis, $F_2(1, 30) = 19.93, MSE = 7,974, p < .001$ (see Figure 2). This effect reflects a pattern in which participants took longer to process the target phrase following an imperfective verb than a perfective verb when there was an intervening sentence between the aspect sentence and the target phrase (631 ms vs. 559 ms), $t(63) = 3.31, p < .01$ but not when there was no intervening sentence (612 vs. 604 ms), $t(63) = 0.27, p > .50$. These results are
inconsistent with those of Magliano and Schleich (2000) who showed that as more and more text becomes available after the aspect sentence, the perception of an event as ongoing (due to its expression in imperfective aspect) starts to fade away. However, Magliano and Schleich’s results could be an artifact of a task that probed for memory of the previous text. Another possible explanation for the different pattern of interaction obtained in the current study could be that the neutral intervening sentence may allow for the initial interpretation of a previously mentioned event as ongoing to become more entrenched in the representation, thus making it more difficult for readers to revise/update their interpretation when encountering a target phrase that signals that the action is already complete. Of course, Magliano and Schleich used up to three intervening sentences whereas the passages in the current study included either none or one. An interesting follow-up study would be to increase the number and kind of intervening sentences in the passages in order to investigate the factors that contribute to the stability or fragility of the imperfective/in progress interpretation of a verb.

![Figure 2](image.png)

Figure 2. First pass fixation time on the target phrase as a function of aspect (imperfective vs. perfective) and continuity (no intervening sentence vs. intervening sentence). Note: Error bars represent SEs.
There was no main effect of age (both subject and item $ps > .10$). In other words, older adults did not require more time to process the target phrase when it was first encountered than did younger adults. Furthermore, age did not interact with any of the text manipulations (all $ps > .10$). This finding is consistent with previous research showing that semantic and syntactic processes are preserved with normal aging (Daneman et al., 2006; Waters & Caplan, 2005).

There was a main effect of reading comprehension skill on first pass fixation time. Skilled readers spent less time fixating the target phrase (555 ms) than did less-skilled readers (648 ms), $F_1(1, 60) = 9.98, MSE = 109,345, p < .01$ and $F_2(1, 60) = 106.63, MSE = 13,625, p < .001$. This finding is not theoretically interesting for the goals of the current study because it simply replicates a common finding that skilled readers are faster than less-skilled readers (e.g., Kemper et al., 2004). More theoretically important was the finding that reading skill did not interact with the text variables (all $ps > .05$), a finding that suggests that less-skilled readers were as sensitive to the aspect manipulation as were skilled readers. Failure to find a reading skill by aspect interaction might initially appear inconsistent with previous studies showing that less-skilled readers are more susceptible to partial or incomplete processing of text than are skilled readers (Hannon & Daneman, 2004; Long et al., 1997; Zwaan & Brown, 1996). However, it is important to point out that the uptake of aspect information in the passages used in the current study is likely different from the uptake of semantic information in sentences containing potential incongruencies.

**Looks Back to Aspect Phrase**

As Table 3 shows, the overall rate of looking back to the aspect verb after encountering the target phrase was low. However, both the probability of refixating the aspect verb and the
amount of time spent refixating were greater for imperfective passages than perfective passages, providing further evidence that readers spontaneously encode verb aspect into their mental representations of text. An ANOVA performed on the probability of looking back to the aspect verb showed that participants were more likely to regress back to an imperfective aspect verb (0.14) than to a perfective aspect verb (0.08) after encountering a target phrase that implies the completion of the earlier event (see Table 3). This main effect was highly significant by subjects, $F_1(1, 60) = 21.15, MSE = 0.024, p < .001$, and by items, $F_2(1, 30) = 11.38, MSE = 0.039, p < .01$. The analysis of the time spent looking at the aspect verb on refixation provided converging evidence for this finding: readers spent on average 22 ms looking back to the imperfective verb and only 9 ms looking back to the perfective verb, $F_1(1, 60) = 27.19, MSE = 890, p < .001; F_2(1, 30) = 23.65, MSE = 997, p < .001$. When only those trials in which participants looked back to the aspect phrase were included in the analysis, the results showed that readers spent an average of 262 ms re-reading the imperfective verb and only 228 ms rereading the perfective verb. These findings suggest that readers had more difficulty processing and integrating the imperfective aspect information when a necessarily subsequent activity was encountered in the text.

Further analyses showed that older adults were more likely to make regressive fixations to the aspect verb (whether imperfective or perfective) than were their younger counterparts (0.13 vs. 0.08), $F_1(1, 60) = 8.53, MSE = 0.035, p < .01$, and, $F_2(1, 30) = 5.60, MSE = 0.049, p < .05$, and they also spent more time on refixations relative to the younger participants (19 ms vs. 12 ms), $F_1(1, 60) = 5.69, MSE = 1278, p < .05$, and, $F_2(1, 30) = 4.45, MSE = 1120, p < .05$. These findings replicate previous studies that showed that older readers are more likely to make regressions and tend to spend more time rereading previous text than do younger readers (e.g., Daneman et al., 2006; Kemper et al., 2004). More importantly, age did not interact with any of
the text variables, including verb aspect (all \( ps > .05 \)), supporting previous research showing preserved syntactic processing with normal aging (Waters & Caplan, 2005).

There was a main effect of reading comprehension skill on the probability of looks back to the aspect verb (both imperfective and perfective); skilled readers were more likely than less-skilled readers to look back to the aspect verb (0.13 vs. 0.08), \( F_1(1, 60) = 10.07, MSE = 0.035, p < .01 \), and \( F_2(1, 30) = 8.34, MSE = 0.030, p < .01 \). Furthermore, skilled readers spent on average 20 ms looking back to the aspect verb, whereas less-skilled readers spent only 9 ms looking back to the aspect verb, an 11 ms difference that was significant by subjects, \( F_1(1, 60) = 6.56, MSE = 1278, p < .05 \), and by items, \( F_2(1, 30) = 6.66, MSE = 732, p < .05 \). This result is somewhat surprising in light of the typical finding that skilled readers engage in fewer regressions than less skilled readers (e.g., Calvo, 2004; Just & Carpenter, 1980). However, recall that skilled readers spent less time than less-skilled readers reading the target phrase, so there may have been a kind of trade-off at work.

Potentially more theoretically interesting to the goals of the current study was the significant three-way interaction between aspect, continuity, and reading comprehension skill on the probability of looking back to the aspect verb, \( F_1(1, 60) = 5.49, MSE = 0.016, p < .025 \) (see Figure 3). Post hoc comparisons revealed that both skilled and less-skilled readers were more likely to look back to an imperfective verb than to a perfective verb. However, skilled readers were more likely to look back when there was an intervening sentence between the aspect sentence and the target phrase (0.15 vs. 0.05), \( t(30) = 4.51, p < .001 \), but not when there was no intervening sentence (0.19 vs. 0.15), \( t(30) = 1.50, p > .10 \), whereas less-skilled readers were more likely to look back when there was no intervening sentence between the aspect sentence and the target phrase (0.15 vs. 0.08), \( t(32) = 3.04, p < .01 \), but not when there was an intervening
sentence (0.08 vs. 0.04), \( t(32) = 1.42, p > .10 \). (A similar pattern of results was found for look back time.) It is not immediately clear how to interpret this reading-skill dependent pattern of regressive eye movements. Remember that the first pass fixation time data revealed that less-skilled readers were as sensitive to the aspect manipulation as were skilled readers regardless of whether a sentence did or did not intervene (there was no significant reading skill \( \times \) aspect interaction and no significant skill \( \times \) aspect \( \times \) intervening sentence interaction for first pass fixation times). So this pattern of looks back to the aspect region probably had more to do with the recovery/resolution styles of skilled versus less skilled readers. Previous research has shown that readers frequently look back to a problem source as part of the recovery/verification process (Carpenter & Daneman, 1981), and that working memory capacity plays a role in how long readers can maintain tags to the location of problem sources in working memory (Daneman & Carpenter, 1983). Less skilled readers typically have lower working memory capacities than do skilled readers (Daneman & Carpenter, 1980; Masson & Miller, 1983). So one possible explanation for the pattern found in Figure 3 is that less-skilled readers are more likely to look back to an imperfective verb that is one sentence back than two sentences back because they are more likely to still have tags to that recently processed one-sentence back verb in working memory. On the other hand, skilled readers will still have tags to the two-sentence back imperfective verbs in working memory, and will readily consult them as part of the resolution/verification process. Of course, this interpretation is post hoc and indirect. Future research should include a measure of working memory capacity to investigate the recovery heuristics more directly. And in any case, some caution is required in interpreting these results because this three-way interaction was not significant by items for either the probability of looking back (\( p > .20 \)) or for look-back time (\( p > .10 \)).
Summary and Conclusions

Previous research showed that imperfective and perfective aspects trigger different mental representations during language comprehension. The goal of the current study was to evaluate how this information guides a reader's interpretation of a sequence of events in written discourse.

One of the very few past studies investigating the effects of verb aspect on the representation of a narrative found that participants were more likely to perceive an event as ongoing in subsequent text if the description of that event was in imperfective rather than perfective aspect (Magliano & Schleich, 2000). Moreover, as indicated by the answers to the probe questions, this aspect effect was larger for long duration events compared to short duration events. In addition, the aspect effect decreased as the amount of intervening text between the aspect sentence and the probe question increased. However, responses to probe questions may

Figure 3. Depiction of the interaction between reading comprehension skill, aspect, and continuity on the probability of looking back to the aspect verb. Note: Error bars represent SEs.
simply reflect readers’ retrieval and use of previously encountered text information when explicitly asked for it rather than their spontaneous construction of mental representations during reading (e.g., Baggio et al., 2008). Hence, the main goal of the present study was to explore how aspect information guides the construction of mental representations using a task that requires nothing more than normal reading for comprehension. In addition, I investigated whether reading comprehension skill and age are related to online processing of aspect information.

The first pass fixation time on the target phrase revealed that readers required more cognitive resources to process this phrase when a necessarily prior event was expressed using imperfective vs. perfective aspect. Furthermore, the probability of look-back to the aspect verb suggested that readers were more likely to revisit the aspect verb after reading the target phrase if imperfective aspect was used compared to when perfective aspect was used. These data are generally consistent with the findings obtained by Magliano and Schleich (2000). However, I extended their observations by showing that readers exhibit sensitivity to aspect information in the earliest moments of processing, and even when they do not have to perform any additional task besides normal reading. Furthermore, first pass fixation times for the target phrase also revealed that people integrate grammatical cues with world knowledge spontaneously when reading. When the aspect sentences described long events, the participants were slower to read the target phrase when the preceding event was described using imperfective aspect compared to perfective aspect. In contrast, when the aspect sentences depicted short events, the first pass fixation time on the target phrase were similar regardless of the aspect used to express the earlier event. In this regard, Magliano and Schleich's (2000) claim that people use both world knowledge and verb aspect information when constructing mental representations of a particular text were also replicated using the task implemented in the current study. Further, when there
was an intervening sentence between the aspect sentence and the target phrase, the participants read the target phrase in the imperfective condition longer compared to the perfective condition. However, the aspect effect disappeared when there was no intervening sentence between the aspect sentence and the target phrase. This outcome is inconsistent with the findings reported by Magliano and Schleich (2000) whereby increases in the amount of text following the aspect sentence reduced the perception of the event described in an imperfective aspect as "ongoing". However, it is possible that one intervening sentence is not enough for the sense of ongoing activity to fade away from one’s memory (Magliano and Schleich varied between zero and three intervening sentences in their study). But importantly, the pattern in the current study was that the neutral intervening sentence material seemed to allow the interpretation of the previously-mentioned event as "ongoing" to become more entrenched, thus making it more difficult to integrate the information contradicting to this interpretation. This outcome is unpredicted on Magliano and Schleich's account. It would appear, then, that the effect of additional sentence material should not be considered only in terms of the potential to cause memory interference or decay, but also in terms of the potential to sustain or even strengthen previously-established interpretations of events described in the text.

Finally, the analyses of first pass fixation time and the probability of looking back to the aspect verb showed that age and comprehension skill did not interact with the aspect variable or other text variables in any theoretically significant way. With respect to age, the findings obtained in this study are consistent with the previous research showing that linguistic abilities are preserved with normal aging (e.g., Daneman et al., 2006; Waters & Caplan, 2005). On the other hand, the failure to find a reading skill by aspect interaction may be argued to be inconsistent with the research showing that less-skilled readers are more prone to engaging in
partial and incomplete semantic and syntactic processing (e.g., Hannon & Daneman, 2004; Kemper et al., 2004). However, it is important to point out that grammatical aspect information is a comparatively frequent and unambiguous cue compared to the types of syntactic constructions and misleading semantic materials used in these studies. In summary, then, the processing and mental representation of a subtle informational cue such as verb aspect appears to be very similar across different age and reading skill groups during reading.
References


Appendix A

List of Experimental Passages (with target phrase in bold)

| Introduction: | It was finally the time for Wendy to visit her brother James in New York City. |
| Aspect sentence: | She was driving/drove from Montana to New York. |
| Intervening sentence: | It felt great to be on holiday. |
| Sentence with the target phrase: | She walked across Times Square to their meeting place. |
| Concluding sentence: | They ran into each other’s arms and spent hours sharing stories from their childhood. |
| True or false statement: | Wendy’s brother’s name is James. |

| Introduction: | Mr. Adams was always fascinated by his wife’s abilities. |
| Aspect sentence: | She was knitting/knitted a new sweater. |
| Intervening sentence: | This time it was for herself rather than for someone else. |
| Sentence with the target phrase: | She wore her new garment on Christmas Eve. |
| Concluding sentence: | Everyone thought the sweater was just amazing. |
| True or false statement: | People loved Mrs. Adams’s sweater. |

| Introduction: | It was exciting to finally have a creative outlet. |
| Aspect sentence: | Beth was painting/painted a new series of landscapes. |
| Intervening sentence: | Her family was very supportive. |
| Sentence with the target phrase: | She exhibited her new collection in an exclusive New York gallery. |
| Concluding sentence: | All the paintings were sold in a few days. |
| True or false statement: | Beth did not like the opportunity to exhibit her artwork. |

| Introduction: | Only a few music enthusiasts knew the songs by the new British punk rock group The Soundscape. |
| Aspect sentence: | The band was recording/recorded their first major CD. |
| Intervening sentence: | The producer gave the group all the freedom they wanted. |
| Sentence with the target phrase: | They sold a million copies of the new album in one week. |
| Concluding sentence: | This marked the beginning of the punk rock era. |
| True or false statement: | The new Soundscape album was the last popular punk rock CD. |

| Introduction: | Sally worked as an entertainment correspondent for a local newspaper. |
| Aspect sentence: | She was watching/watched a newly released movie at the cinema. |
| Intervening sentence: | The director of the film was her friend. |
| Sentence with the target phrase: | Sally wrote a great review article about the movie. |
| Concluding sentence: | The editor loved her piece and included it in the weekend edition. |
| True or false statement: | Sally was an entertainment correspondent. |
Introduction: It was the biggest storm in the past ten years.
Aspect sentence: The divers *were rescuing/rescued* a boy trapped in the sinking cruise ship.
Intervening sentence: The weather conditions were harsh.
Sentence with the target phrase: They *were honoured with medals* of bravery for their skill and courage.
Concluding sentence: However, the best reward was the lives they saved.

True or false statement: The divers cared about the lives they saved more than their medals.

Introduction: Dr. Sullivan was a long-time member of the hospital surgical team.
Aspect sentence: He *was operating/operated* on Mrs. Jones to remove a tumour.
Intervening sentence: It was his one hundredth surgery.
Sentence with the target phrase: Dr. Sullivan dropped by the waiting room to let the family know that the procedure was over.
Concluding sentence: Once again everyone acknowledged his incredible surgical skills.

True or false statement: Dr. Sullivan had just graduated from medical school.

Introduction: Tom was very excited about his trip to the West Coast.
Aspect sentence: He *was flying/flew* from Toronto to Vancouver.
Intervening sentence: Summer had just begun.
Sentence with the target phrase: Tom *swam in the Pacific Ocean* for the first time in his life.
Concluding sentence: The natural beauty of the West Coast was unforgettable.

True or false statement: Tom hated the landscape of the West Coast.

Introduction: Bob was a troubled young man.
Aspect sentence: He *was serving/served* a three-year prison sentence.
Intervening sentence: The penitentiary was in rural Texas.
Sentence with the target phrase: Bob *said good-bye to his fellow inmates*.
Concluding sentence: He looked forward to reuniting with his family.

True or false statement: Bob had been a troubled person.

Introduction: Fred Smith was a cycling legend.
Aspect sentence: He *was riding/rode* in the last 200-km race of his career.
Intervening sentence: The route was very challenging.
Sentence with the target phrase: Fred *raised the championship trophy* with tears in his eyes.
Concluding sentence: What a way to end a career!

True or false statement: Fred Smith ended his career on a nice note.

Introduction: *The Dawn* was one of the best-selling books of all time.
Aspect sentence: Jared Stevenson *was shooting/shot* a film version of the book in southern California.
Intervening sentence: The cast consisted of famous actors.
Sentence with the target phrase: He *released the movie on DVD* due to popular demand.
Concluding sentence: However, the film never achieved the success of the novel.

True or false statement: *The Dawn* was a very unpopular book.
Introduction: Joe enjoyed the summer at his cabin.
Aspect sentence: He was building/built a cedar strip canoe from scratch.
Intervening sentence: It was nice to spend time working outside.
Sentence with the target phrase: Joe paddled his new boat down the Mississippi river.
Concluding sentence: He felt proud of his achievement.

True or false statement: Joe was not very interested in his new canoe.

Introduction: Kristen got engaged to Steve almost a year ago.
Aspect sentence: She was sewing/sewed her own dress for the wedding.
Intervening sentence: The design was very non-traditional.
Sentence with the target phrase: Kristen walked down the aisle looking fabulous.
Concluding sentence: Steven could not take his eyes off his beautiful bride.

True or false statement: Kristen and Steve got engaged almost a year ago.

Introduction: It was opening night at the Opera.
Aspect sentence: Emma was performing/performed in the lead role for the first time.
Intervening sentence: It was a dream come true.
Sentence with the target phrase: She received a standing ovation and a bouquet of flowers.
Concluding sentence: The critics were full of praise.

True or false statement: The critics really liked Emma’s performance.

Introduction: John was commissioned to build a monument commemorating a national hero.
Aspect sentence: He was casting/casted a three-meter tall bronze sculpture.
Intervening sentence: It was flattering to be entrusted with such a work.
Sentence with the target phrase: John held his breath as the mayor unveiled the statue to the public.
Concluding sentence: Applause filled the town square.

True or false statement: John was asked to build a house.

Introduction: It was the beginning of the spring semester at Bixby College.
Aspect sentence: Professor Madden was giving/gave a three-hour-long lecture on foreign policy in the Middle East.
Intervening sentence: Clearly, it was a very controversial issue.
Sentence with the target phrase: He left the lecture hall to find a crowd of reporters clamoring for an interview.
Concluding sentence: There was no escape.

True or false statement: Professor Madden left the building without any publicity.
| Introduction | It was time for the annual company meeting in Paris. |
| Aspect sentence | Paul was packing/packed a suitcase with his belongings. |
| Intervening sentence | His future in the company was at stake. |
| Sentence with the target phrase | He drove to the airport in five minutes flat. |
| Concluding sentence | The plane took off on time. |
| True or false statement | The annual company meeting was taking place in Paris. |

| Introduction | Stephanie wished she had followed her mechanic's advice. |
| Aspect sentence | She was changing/changed a flat tire on the side of a busy road. |
| Intervening sentence | Her friends would be very impressed with her. |
| Sentence with the target phrase | She left the highway at the earliest opportunity to look for a garage. |
| Concluding sentence | Fortunately a service station was just a few kilometers away. |
| True or false statement | The service station was near the highway. |

| Introduction | The high-profile trial was coming to an end. |
| Aspect sentence | Judge Warner was entering/entered the courtroom. |
| Intervening sentence | The expression on his face was stern. |
| Sentence with the target phrase | He sentenced the defendant to life in prison. |
| Concluding sentence | No one had anticipated such a harsh sentence. |
| True or false statement | It was a low-profile trial no one knew about. |

| Introduction | Jerry had to pay his electricity bill. |
| Aspect sentence | He was writing/wrote a personal cheque. |
| Intervening sentence | This month’s bill was unusually high. |
| Sentence with the target phrase | Jerry sent the payment by mail. |
| Concluding sentence | He worried how he could pay the rest of his monthly bills. |
| True or false statement | Jerry did not care about paying his bills. |

| Introduction | The big track and field championship was in Berlin. |
| Aspect sentence | Bruce was running/ran a heat in the hundred-meter dash. |
| Intervening sentence | The competition was stiff. |
| Sentence with the target phrase | He celebrated at the finish line with the other qualifiers. |
| Concluding sentence | His coach was very proud of him. |
| True or false statement | The competition was held in Berlin. |

| Introduction | Carl was a fitness freak. |
| Aspect sentence | He was doing/did his last fifty pushups. |
| Intervening sentence | Everyone else was long gone. |
| Sentence with the target phrase | Carl showered in the locker room with no one around. |
| Concluding sentence | Even he was feeling a burn in his arms. |
| True or false statement | Carl felt tired after his workout. |
Introduction: It was time for the graduation party.
Aspect sentence: Susan was taking/took a shower.
Intervening sentence: It felt good to have finally finished with her studies.
Sentence with the target phrase: She blow-dried her hair and put it in a ponytail.
Concluding sentence: Susan’s classmates thought that she looked stunning.

True or false statement: It was a housewarming party.

Introduction: Adrian was having a dinner party to celebrate his pr
omotion.
Aspect sentence: He was setting/set the table for the party.
Intervening sentence: Only his closest friends were invited.
Sentence with the target phrase: Adrian enjoyed the meal together with his guests.
Concluding sentence: They had Hungarian stew with mashed potatoes.

True or false statement: Adrian prepared a French dish for the party.

Introduction: It was a very special Christmas morning.
Aspect sentence: Little Grace was opening/opened her grandparents’ gift.
Intervening sentence: It was her second Christmas.
Sentence with the target phrase: She played with the new Barbie doll for hours.
Concluding sentence: The present was an obvious success.

True or false statement: The family celebrated Christmas.

Introduction: Finally, the horrible day at the office was over.
Aspect sentence: Kathleen was brushing/brushed her teeth.
Intervening sentence: Work occupied her mind to the exclusion of all else.
Sentence with the target phrase: She went to bed to get rest before another busy day tomorrow.
Concluding sentence: The weekend seemed so far away.

True or false statement: Kathleen thought the weekend felt far off.

Introduction: Agnes was a single mother.
Aspect sentence: She was videotaping/videotaped her son playing in the park.
Intervening sentence: The playground was full of happy children.
Sentence with the target phrase: Agnes uploaded the video on YouTube.
Concluding sentence: The video got a lot of hits.

True or false statement: Agnes was happily married.

Introduction: There is nothing more satisfying than making a salad with homegrown vegetables.
Aspect sentence: Jane was picking/picked some tomatoes and lettuce from her organic garden.
Intervening sentence: The growing conditions were perfect that summer.
Sentence with the target phrase: She tasted the salad and thought it was delicious.
Concluding sentence: Her family could not agree more.

True or false statement: Jane’s family did not like the salad.
| Introduction: | The weather conditions were not promising a smooth flight. |
| Aspect sentence: | The pilot *was landing/landed* the plane in rough weather. |
| Intervening sentence: | It felt frightening. |
| Sentence with the target phrase: | He *climbed out of the cockpit* and breathed a sigh of relief. |
| Concluding sentence: | The pilot deserved a stiff drink. |
| True or false statement: | The weather forecast was not great for flying. |

| Introduction: | It was evening at the boy scout camp. |
| Aspect sentence: | Glen *was lighting/lit* a fire. |
| Intervening sentence: | The sunset looked beautiful. |
| Sentence with the target phrase: | He *grilled some hamburgers* for the hungry campers. |
| Concluding sentence: | The scouts gobbled them down quickly. |
| True or false statement: | It took a very short time for scouts to finish all the food. |

| Introduction: | Java Hut was voted as the best café in town. |
| Aspect sentence: | The barista Sam *was making/made* a large latte for a new customer. |
| Intervening sentence: | It was a cold and rainy day. |
| Sentence with the target phrase: | He *received a good tip* for the delicious drink. |
| Concluding sentence: | It was nice to see another happy customer. |
| True or false statement: | Java Hut had a very bad reputation. |

| Introduction: | Alan fell off his bike and scraped his knee. |
| Aspect sentence: | His mother *was carefully cleaning/cleaned* the wound with disinfectant. |
| Intervening sentence: | It was the second mishap of the week. |
| Sentence with the target phrase: | She *wrapped a bandage* around the knee. |
| Concluding sentence: | Alan jumped right on his bike and headed back to the park again. |
| True or false statement: | Alan had to stay in bed until he could play again. |
### Appendix B
#### Complete Set of Data

*Mean First Pass Fixation Time on the Target Phrase (in milliseconds) as a Function of Aspect, Event Duration, Continuity, Reading Skill, and Age*

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Mean Probability of Look Backs as a Function of Aspect, Event Duration, Continuity, Reading Skill, and Age

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### Mean Look Back Time on the Aspect Verb as a Function of Aspect, Event Duration, Continuity, Reading Skill, and Age

| Aspect Verb | Younger adults | | Older adults | | |
|-------------|----------------|---|----------------|---|
|              | Younger adults | Older adults | | |
|              | Skilled (n = 17) | Skilled (n = 14) | Skilled (n = 17) | Skilled (n = 14) | |
|              | Less-skilled (n = 15) | Less-skilled (n = 18) | All Young (n = 32) | All Older (n = 32) | |
|              | M   | SD  | M   | SD  | M   | SD  | M   | SD  | M   | SD  | M   | SD  |
| Imperfective | | | | | | | | | | | | |
| Long duration | | | | | | | | | | | | |
| No intervening sentence | 6 | 19 | 26 | 55 | 16 | 41 | 48 | 41 | 15 | 20 | 29 | 35 |
| Intervening sentence | 27 | 41 | 3 | 9 | 16 | 32 | 29 | 47 | 9 | 20 | 17 | 35 |
| Mean | 17 | 20 | 15 | 28 | 16 | 24 | 38 | 36 | 12 | 14 | 23 | 28 |
| Mean | 21 | 17 | 15 | 19 | 18 | 18 | 34 | 30 | 19 | 18 | 26 | 25 |
| Short duration | | | | | | | | | | | | |
| No intervening sentence | 32 | 43 | 25 | 44 | 29 | 43 | 44 | 56 | 49 | 63 | 47 | 60 |
| Intervening sentence | 18 | 24 | 4 | 10 | 11 | 20 | 17 | 27 | 5 | 16 | 10 | 22 |
| Mean | 25 | 30 | 14 | 24 | 20 | 27 | 31 | 27 | 27 | 31 | 29 | 29 |
| Mean | 21 | 17 | 15 | 19 | 18 | 18 | 34 | 30 | 19 | 18 | 26 | 25 |
| Perfective | | | | | | | | | | | | |
| Long duration | | | | | | | | | | | | |
| No intervening sentence | 13 | 19 | 9 | 18 | 11 | 19 | 27 | 32 | 8 | 18 | 16 | 27 |
| Intervening sentence | 5 | 15 | 2 | 8 | 4 | 12 | 4 | 11 | 3 | 11 | 3 | 11 |
| Mean | 9 | 11 | 5 | 12 | 7 | 11 | 15 | 16 | 5 | 13 | 10 | 15 |
| Short duration | | | | | | | | | | | | |
| No intervening sentence | 8 | 19 | 4 | 16 | 6 | 18 | 30 | 46 | 16 | 29 | 22 | 37 |
| Intervening sentence | 0 | 0 | 3 | 10 | 1 | 7 | 3 | 11 | 2 | 8 | 2 | 9 |
| Mean | 4 | 10 | 3 | 9 | 4 | 9 | 17 | 22 | 9 | 16 | 12 | 19 |
| Mean | 7 | 8 | 4 | 8 | 6 | 8 | 16 | 11 | 7 | 12 | 11 | 12 |