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Immediate Repeated Reading has Positive Effects on Reading Fluency for English Language Learners: An Eye-tracking Study

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ABSTRACT

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Fluent reading has been described as the ability to read a passage with accuracy, at a steady rate, with minimal hesitancy, and good comprehension (Grabe, 2009; Kuhn, Schwanenflugel, & Meisinger, 2010). Dysfluent reading can affect motivation for reading in English language learners, thereby limiting access to a wealth of language input from written texts (Taguchi, Gorsuch, & Sasamoto, 2006). Extensive research of repeated reading in L1 settings has been shown to increase reading fluency (Samuels, 1979; National Reading Panel, 2000), while comparatively little research has been done on repeated reading in L2 settings (Grabe, 2009). The objective of this eye-tracking study was to accurately document lower-level and higher-level reading processes in an immediate repeated reading exercise to observe how repeated reading affects reading fluency in adult English language learners. In our study, 30 students in an intensive English program in the United States read three short expository texts three times each. Eye-tracking showed significant increases in reading fluency measures in both lower-level and higher-level reading functions. For example, average first fixation duration decreased by 15 ms from the first to the third reading and average late dwell time decreased by 40 ms from the first to third reading. Repeated reading is an exercise that should be considered by educators to help English language learners increase their reading fluency with immediate repeated reading of expository texts.

Keywords: English as a second language, eye-tracking, repeated reading, reading fluency

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

Fluent reading has been described as the ability to read a passage with accuracy, at a steady rate, with minimal hesitancy, and good comprehension (Grabe, 2009; Kuhn, Schwanenflugel, & Meisinger, 2010). Extensive research has been done on reading fluency in first language, or L1, settings while comparatively little has been done on reading fluency in second language, or L2, settings. It is common for L2 learners to read in a second language with fair comprehension but with limited fluency, including reading speed half to a third the rate of an L1 reader (Fraser, 1989; Grabe, 2009). In an academic setting this puts L2 students at a significant disadvantage. L2 reading researchers have stressed the need for more attention to fluency in reading instruction (Anderson, 1999; Grabe, 2009; Nation, 2009).

Dysfluent reading can affect motivation for reading. If reading is difficult and a great deal of energy is being used to decode words, reading can feel like drudgery. The effort given to lower-level reading processes, i.e. decoding individual words, also takes attention from comprehending what is being read. The National Reading Panel, which analyzed studies of L1 reading fluency in the United States noted, "If text is read in a laborious and inefficient manner, it will be difficult for the [reader] to remember what has been read and to relate the ideas expressed in the text to his or her background knowledge" ("Report," n.d., para. 33). The panel also reported that extensive research has shown that good readers read more often than poor readers although the findings are correlational; meaning it is uncertain if good readers read more because they are good at it, or if reading more has helped them become good readers (NPR, 2000). Dysfluent reading can have detrimental effects on L2 learners' language acquisition because the difficulty of reading will discourage them from doing it, which will distance them from a tremendous source of language input (Taguchi, Gorsuch, & Sasamoto, 2006).

Reading fluency involves lower-level (or bottom-up) and higher-level (or top-down) processes. Lower-level processes include graphemic awareness, understanding of phonemes, and word recognition (Goodman, 1967; Samuels & Laberge, 1974). Grabe (2007) explains, "In order for fluent word recognition to occur, a reader must recognize the word forms on the page very rapidly, activate appropriate links between the graphic form and phonological information, activate appropriate semantic and syntactic resources, recognize morphological affixation in more complex word forms, and access her or his mental lexicon" (p. 23). Higher-level processes focus on what the reader does to make sense of the text by activating background knowledge, interpreting through context and making inferences (Goodman, 1967; Perfetti, 1980, 1985, 1988; Grabe, 2007). Perfetti (1980) explains, "The identification of words is potentially made easier by comprehension of the previous text, or more generally, by knowledge that is relevant for the content of the text. Since the relevant knowledge can come from the reader's mind, it is very general conceptual knowledge that guides the reading. In an important sense then, reading is conceptually guided, or top-down" (p. 3).

The study of reading fluency in L1 settings led Samuels and LaBerge (1974) to develop Automaticity Theory (AT). The theory suggests that lower-level processing skills such as word recognition must become automatic for attention to be given to higher-level skills such as understanding what is being read, or comprehension. If the fundamental process of word recognition is not automatic, the reader cannot focus on comprehension (Meyer & Felton 1999; O'Connor et. al., 2007; Kuhn et. al., 2010). In specific regard to L2 learners Chang and Millett explain, "for L2 readers, lower-level processing seems to be more problematic than higher-level processing because these readers are unable to carry out lower-level processing in an efficient way" (2013, p. 127). Nassaji (2003) found that well-developed lower-level skills, in addition to

higher-level skills, significantly contributed to the difference in ability between skilled and less-skilled L2 readers. Nation explained, "fluency develops when complex activities like reading are made less complex by the fluent mastery of some of the subskills involved in the activity" (2009, p. 135). Automaticity of lower-level reading skills is vitally important for L2 learners because without it reading becomes a laborious and unenjoyable process (Taguchi, Gorsuch, & Sasamoto, 2006).

A complementary and somewhat more expansive theory to AT is Verbal Efficiency Theory (VET) developed by Perfetti (1985, 1988). While Samuels and LaBerge equated automatic reading with lower-level processes such as decoding, Perfetti expanded upon this and explained that automaticity can be developed for higher-level processes as well (Walczyk, 2000). These higher-level processes move beyond word recognition and include interpreting anaphors (determining who is being referred to), activation of relevant background knowledge, recognizing larger phrasal text units, and metacognitive strategies. This theory explains that until higher-level processes become more automatic there is little working memory space for comprehending what is being read (Taguchi & Gorsuch, 2006; Walczyk, 2000).

Developing automaticity in reading takes time and practice. Samuels (1979) describes the processes beginning readers go through to develop this automaticity. It begins with the non-accurate stage where much effort is given to decoding words. The reader's attention is on decoding and not on comprehending what is being read. The next stage is the accurate stage where words are more readily recognized. Readers in this stage read haltingly, despite good word recognition, and comprehension may still be poor. The most advanced stage is the automatic stage when readers can read out loud at a good rate using expression. Because word recognition is accurate and automatic, attention can be given to understanding meaning of what is being read.

Reading researchers have studied various methods to help learners improve fluency, or automaticity and accuracy, in reading. One of the most well-known methods is repeated reading (RR) which has consistently been shown to improve reading fluency in L1 settings. Samuels (1979) established this technique in the 1970s to help L1 children who were struggling with reading and to test Automaticity Theory (Samuels & Laberge, 1974). The method involves the repeated reading of short, meaningful passages until a previously determined goal of speed and accuracy is reached. Our study examines RR by English language learners in an L2 context. The expectation is that based on the two theories, L2 readers will see an improvement in their reading fluency over the course of three immediate repetitions.

Review of Literature

Repeated Reading

In the L2 classroom where reading instruction is given, the focus of reading has traditionally been to support grammar, vocabulary, and comprehension without necessarily emphasizing reading fluency (Stoller, Anderson, Grabe, & Komiyama, 2013). There seems to be an assumption among L2 educators that reading fluency will improve as general language proficiency improves (Gorsuch & Taguchi, 2008). Advocates for a greater focus on fluency in L2 reading instruction recommend repeated reading (RR) as one method among several that can be used to support a reading curriculum in the L2 classroom (Anderson, 1999; Nation, 2009; Stoller, Anderson, Grabe, & Komiyama, 2013). Anderson explained that reading fluency activities in the L2 classroom are important, specifically RR, because learners "understand more when reading something twice at a faster reading rate than when reading it slowly only one time" (1999, p. 3). RR can be used in L2 settings as a method for improving reading fluency because rereading a familiar text helps the students to concentrate on reading faster and with more

automaticity, thus freeing cognitive space for comprehension (Gorsuch & Taguchi, 2010; Stoller, Anderson, Grabe & Komiyama, 2013).

RR can be done silently, orally, with audio assist, modeling, or a combination of any of these methods. Samuels (1979) suggests that the passages shouldn't be too difficult, and the students should understand that they are *practicing* reading in order to improve--much like an athlete practices to become better at their sport. In Samuels' study on L1 readers, the learners' speed increased and their recognition errors decreased with each subsequent reading. Even more promising, starting rates were faster with each new passage read and fewer re-readings were required to meet the predetermined goal. These results indicate that the fluency gains in the initial repeated readings were carried over to new readings (Samuels, 1979). Similar results have been shown in many other L1 studies as well (e.g., Therrien and Kubina, 2006; Kuhn, 2004; Crosson and Lesaux, 2010; National Reading Panel, 2000; O'Conner, White, & Lee, 2007). The National Reading Panel reviewed 364 studies on RR in L1 settings and found that "such procedures had a consistent, and positive impact on word recognition, fluency, and comprehension as measured by a variety of test instruments and at a range of grade levels" (2000, p. 33). Decades of study of reading fluency development in L1 settings have shown that specific classroom instruction with reading activities like RR significantly improve reading fluency (NPR, 2000; Grabe, 2009).

L2 practitioners have been doubtful about implementing fluency activities in the classroom for a variety of reasons. Gorsuch and Taguchi report that it is "likely that teachers and learners in L2/FL settings may be unaware of or unconvinced of the role increased reading fluency plays in reading comprehension and, as a result, may not see the utility of devoting class or personal time to RR or, indeed, any reading fluency activity" (p. 27, 2010). Furthermore, very

little research exists on RR in L2 settings. Relatively few studies have been conducted and the results have been mixed because of methodological inconsistencies (e.g., Taguchi & Gorsuch, 2002; Taguchi, Takayasu-Maass, & Gorsuch, 2004; Taguchi, Gorsuch, & Sasamoto, 2006; Gorsuch & Taguchi, 2008; Gorsuch & Taguchi, 2010; Chang, 2012; Jeon, 2012; Chang & Millet, 2013).

L2 Studies on Repeated Reading

In 2002 Taguchi and Gorsuch performed a study with 18 beginning to intermediate level Japanese EFL students in which nine participated in a RR activity three times a week for ten weeks. They read narrative passages in a novel seven times each with three of the readings utilizing audio assistance. They recorded their words per minute using self-timing. The remaining nine students were a control group who did not receive the RR treatment, but instead had an enriched reading experience with leveled reading cards. The researchers were hoping to replicate results of L1 studies in which students who practiced RR showed gains in fluency and in comprehension which also transferred over into reading new passages. At the conclusion of the study, those in the experimental group had significant improvement (measured by *t*-tests) in their silent reading rates (words per minute) from the pretest to the posttest while the control group did not. However, when comparing the pretest and posttest comprehension scores of the experiment group to the control group, there was not a significant difference between the two. The results were inconclusive. The researchers recognized their limitations (one of which was the relatively short 10-week period) and that more studies were needed to show effective gains from RR.

A follow-up study was done in 2004 with 23 beginning level Japanese EFL students for 17 weeks (Taguchi, Takayasu-Maass, & Gorsuch). In the RR sessions the students read narrative

texts from books for leveled reading instruction five times with audio-assist for two of the times. The results showed a significant increase in silent reading speed over the course of the study and that the students greatly improved speed within each individual session. “The readers read each new passage closely and increasingly faster as the number of RR sessions progressed. Consequently, the reading gains from practiced passages were transferred to new unpracticed passages” (p. 87). The researchers concluded that increasing the treatment period from 10 to 17 weeks intensified the positive effects of RR.

Gorsuch and Taguchi’s 2008 study made some gains in showing RR has a positive impact on comprehension. The participants were 24 Vietnamese intermediate-level EFL students. They were divided into experimental and control groups for an 11-week RR study in which they read narrative texts from books for leveled reading instruction. In support of the previous studies, they had similar results in increased fluency for the experimental group during the RR sessions. The experimental group performed better on the comprehension tests at the end of the study than the control group, but the reading rates between the two groups on the posttest passages were nearly the same. This was somewhat surprising because the experimental group had shown fluency gains similar to previous studies during the individual sessions. The written comments of the participants possibly helped explain the results. The participants in the experimental group reported that they were reading the texts in the posttest carefully because they knew they would be tested for comprehension. They slowed their reading rates to understand more. Their comprehension test scores were significantly higher than the control group. Gorsuch and Taguchi interpreted this in support of Automaticity Theory because the experimental group had gained greater automatic word recognition in the RR exercises and were therefore able to devote more cognition to comprehension. In addition, “That the experimental

group read more slowly than they were capable of in order to do well on the comprehension post-tests also suggests use of metacognitive strategies, suggesting support for Verbal Efficiency Theory" (p. 267).

In 2013 Chang and Millett modeled a 13-week RR treatment after the studies of Gorsuch and Taguchi. The participants were 26 EFL learners from Taiwan. They were divided into experimental and control groups and read from an expository style reading textbook. Over the course of the treatment, the RR group read each passage five times while the control group read each passage only once. Both groups were given the same pre- and post-tests. The results verified the previous studies showing significant improvement in reading fluency for the experimental group. Of note, where the other studies were inconclusive, Chang and Millett were able to show substantial gains in comprehension as well. "The results indicated that students who received RR intervention improved their comprehension levels much more than those who did not and the effect gained from better comprehension of practiced passages could be transferred to the unpracticed passage" (p. 137). They explain that measured transfer of comprehension to new passages was possibly due to the similarity of vocabulary across the readings according to the standards outlined by Nation (2007) for fluency building activities.

The previously mentioned research on RR in L2 settings are among the only studies that have been done. They were all conducted over several months in EFL settings. The previous research has also depended upon self-timed readings where there is the probability for human error. There was also no actual measurement of reading behavior beyond the self-measured speed at which a passage was read.

Rich, Eckstein, Cox, Luke, Wilcox, and Hansen (in process) recently completed an eye-tracking study of RR with intermediate-level L2 students who were enrolled in an intensive

English program in the United States. The students read three narrative texts three times each while an eye-tracking machine followed their eye movements. This was done in a single setting. This eye-tracking study broke down reading behavior to word level with accurate measures of reading speed and provided insight into decoding processes. They found that even with immediate repeated reading, students' fluency improved in both early and late measures of reading. Rich, et al.'s (in process) study of RR used eye-tracking methods and examined ESL learners' early and late RR processes; however, their work focused on narrative texts and overlooked the possibility that expository writing may access different reading processes. Expository texts are written with the intent to share information and are quite different from the story telling purposes of narrative texts. Expository texts often make use of cuing structures such as headings and subheadings and phrases such as *first, second,* and *finally* to guide the reader. In contrast, narrative texts use story structures including setting, characters, a problem, and a solution. Different strategies are required of readers for these types of texts (Saenz & Fuchs, 2002).

Given the impressive potential of RR from the L1 literature and the surprisingly sparse L2 research which is somewhat inconclusive, additional research is needed which can measure L2 RR in more precise and replicable ways.

Eye-Tracking and Reading

Eye-tracking technology provides a unique way of measuring the exact movements of the eye that take place during reading. Full acuity of vision is only achieved in a small area called the fovea, roughly the size of a person's thumb at arm's length (Holmqvuist & Nyström, 2011), although words can be seen and interpreted in the peripheral vision as well. *Fixations* are pauses the eyes make as they focus on a particular word or part of a word. *Saccades* are rapid eye

movements from one fixation to the next without any visual focus in between fixations. *Regressions* are backward saccades, or visual returns to words previously fixated upon for further consideration or correction for over-shooting text (Rayner, 2009; Holmqvist, et.al., 2011; Foster, Arduin, & Binder, 2013; Conklin, Pellicer-Sanchez, & Carrol, 2018). Fixations and saccades can occur within a single word, and some words may not be fixated on at all. Conklin and Pellicer-Sanchez (2016) explain the benefits of using eye-tracking for the study of reading behavior, "First, the amount of time spent fixating an item reflects the cognitive effort required to process it, meaning that longer durations and more fixations indicate greater processing effort and shorter fixations and/or skipping indicate less processing effort. The second supposition is that what is being fixated is what is being considered" (p. 454).

Eye-tracking studies on reading behavior have been primarily used by psychologists and psycholinguists in L1 settings. There have been relatively few eye-tracking studies on English language learners, although the field is gaining some momentum (Conklin & Pellicer-Sánchez, 2016; Conklin, Pellicer-Sánchez & Carrol, 2018). Eye-tracking studies on RR in L1 settings give support to the benefits of RR as a helpful reading fluency practice and also give insights into eye movements during reading, yet they are studies of adults or children reading in their native language, not of English language learners in an ESL setting (Hyönä & Niemi, 1990; Hyönä, 1995; Raney & Rayner, 1995; Schnitzer & Kowler, 2006; Kaakinen & Hyönä, 2007; Foster, Ardoin & Binder, 2013).

Hyönä and Niemi (1990) performed a RR eye-tracking study on native Finnish speakers at a university in Finland. They found that repetition decreased fixation time and increased saccade length in subsequent readings. In a second study in 1995, Hyönä determined that participants didn't spend as much time fixating on sentences introducing new topics during RR.

Raney and Rayner (1995) studied the effects of RR with English speaking university students in Massachusetts. They found that participants had shorter fixation durations, fewer fixations, and longer saccades with two readings of a text. Schnitzer and Kowler (2006) had five participants read four texts 40 times over a period of weeks. They observed global changes in saccades and decreases in regressions with RR. Foster, Ardoin and Binder (2013) studied eye movements in RR with 43 English speaking second grade students in a school in Southeastern United States. The students read each text four times and showed significant decrease in measures of early (first fixation duration and gaze duration) and late measures (total fixation time, regressions, and number of fixations). The greatest changes were between the first and second readings, but there was also a significant decrease between the second and third as well. There was not significance between the third and fourth readings. "Together, these findings suggest that RR has an immediate significant effect on reading rate but, . . . may require three readings to produce optimal results" (p. 151).

Eye-tracking can give insight in to lower-level and higher-level reading functions and provide support for Automaticity and Verbal Efficiency Theories. In eye-tracking these are referred to "early" or "late" measures and can roughly relate to lower and higher-level reading functions. Conklin, et al. (2018) explain, "Early measures are seen primarily as a reflection of highly automatic word recognition and lexical access processes, while later measures tend to reflect more conscious, controlled, strategic processes" (p. 66). There are many ways to measure eye-movements in an eye-tracking study. Examples of some of the eye-tracking measures used by reading researchers are shown in Table 1. These give insight into lower and higher-level reading processes as described previously and are called early and late reading measures (Conklin, Pellicer-Sanchez, & Carroll, 2018).

Table 1

Eye-tracking Measures, Definitions, and Purposes

Measure	Definition
Early reading measures	
Skips	A measure of whether a word was skipped (1 or 0) during first-pass reading. Usually function words are skipped which indicates automatic processing.
First fixation duration (FFD)	The amount of time in milliseconds that a reader spends on the initial fixation of a word if it is not skipped initially. This indicates the time required for immediate word recognition.
First run dwell time (FRD)	The amount of time in milliseconds that a reader spends collectively on all first-pass fixations of a given word if it is not skipped initially. This indicates the total time necessary for word recognition.
Late reading measures	
Run count	The total number of times a reader reads through a word. Indicates the amount of attention required for a reader to consider a word or context in a sentence.
Regressions-in count	The total number of times that a reader looks back at a word (right to left). May indicate the need for more consideration for comprehension.
Late Dwell Time (LDT)	The amount of time in milliseconds spent looking at a word after the first run only if it received more than one run. This measure isolates later reading measures from early reading measures.

Areas of interest (AOIs) are defined in a text as regions where researchers are interested in gathering data (Holmqvist & Nyström, 2011). For example, each word can be defined as an AOI in order to gather specific data on how a word is being read. Any time the reader's eye gaze moves through an AOI is called a run (Rayner, Sereno, Morris, Schmauder, & Clifton, 1989). During the first run if the eyes move over a word without fixating on it, this is called a skip (regardless of whether it is fixated on during a subsequent run) and can indicate that the word is predictable or easily recognizable. This measures whether a word was skipped (1 or 0) during first-pass reading. The first time the eyes fixate in an AOI is measured in milliseconds and is called first fixation duration, or FFD. The FFD can indicate the time needed for decoding or word recognition. The first run dwell time (FRD) is the measurement of the total amount of time the eyes fixate on a word during the first run if not skipped initially (the eyes may fixate on more

than one spot in the AOI after the first fixation). These three measures (skips, FFD, and FRD) all indicate how easily a word is recognized, or decoded, and show automaticity in reading. These measures are used as evidence of a reader's proficiency in lower-level, or early, reading processes.

The eye-tracking measures used to emphasize higher-level, or late reading processes evaluate the times an AOI was looked back to. Regression in count refers to the times a reader looked back (from right to left) to an AOI. Run count is the total number of times a reader's eye gaze passed through an AOI whether from a regression (right to left) or passing over left to right after regression to a previous word. A reader often looks back at a word if there is need for clarification, or if a saccade is inadvertently longer than was intended. The sum of the durations in milliseconds of each fixation in an AOI is the total dwell time. In order to separate the later reading from the FRD, the FRD is subtracted from the total dwell time. This measure is called late dwell time, or LDT. These three measures, regressions-in, run count, and LDT, can show proficiency in higher-level reading skills as they are indicators of readers' strategic moves to increase comprehension.

In summary, the amount of time a word is fixated upon demonstrates the effort needed to comprehend the word. Skipping over a word can indicate that it is highly predictable or frequent and therefore unnecessary to fixate, or possible overreaching during a saccade. Regressions, or looking back to a word, can indicate more work was needed to understand a word (Rayner, 2009; Holmqvist, Nyström, Andersson, Dewhurst, Jarodzka, & Van de Weijer, 2011; Conklin, Pellicer-Sanchez, & Carroll, 2018). These eye-tracking measures all provide much more detail and accuracy in the study of reading than learners self-timing during RR exercises in the classroom (Figure 1).

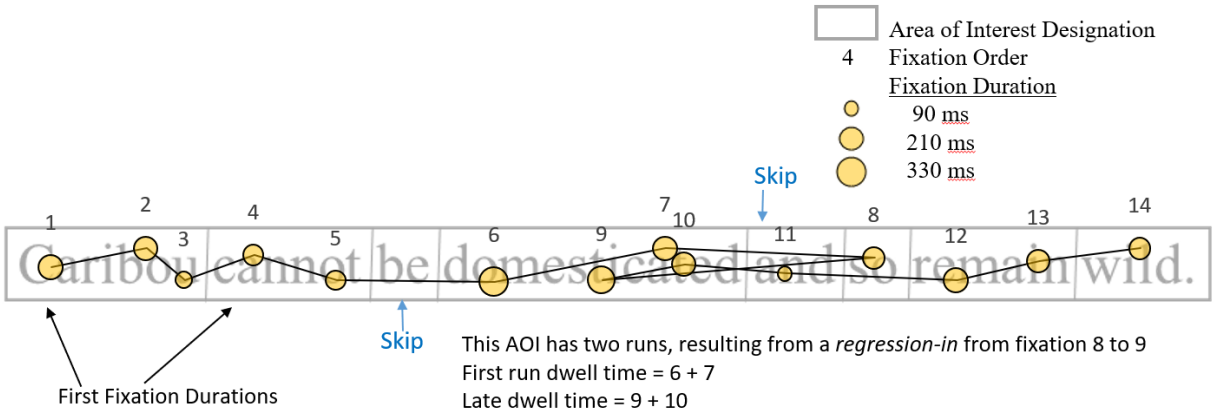

Figure 1. A visual representation of eye-tracking measures.

The purpose of this study was to examine the effects of immediate RR on silent reading fluency of expository texts in adult English language learners. RR is a method that has been shown to help develop reading fluency in the L1 classroom but has had less attention in L2 research or instruction. This eye-tracking study was to develop a more thorough understanding of the actual mechanics of RR while intermediate-level English language learners read short expository passages multiple times. Expository texts are usually defined as texts meant to inform or educate with facts while narrative texts are typically stories written to entertain (Saenz & Fuchs, 2002). Eye-tracking studies work with the assumption that the amount of time spent fixating on a word (dwell time) reflects the amount of cognitive effort required to process it. The longer the eye lingers, the more the word is being considered (Just & Carpenter, 1980). Eye-tracking is described as giving the researcher a "window to the mind" and it allows for study of reading in a "natural" way (Conklin and Pellicer-Sanchez, 2016) thus providing more information about the effects of RR on English language learners' reading fluency.

Motivation and Research Questions

The benefits of repeated reading (RR) as an exercise for increasing reading fluency have been well documented in L1 literature and classroom practice. As previously mentioned, fluency activities like RR have been slower to be implemented in the L2 classroom. In addition, there have been few eye-tracking studies on English language learners and RR eye-tracking studies on adult English language learners are practically non-existent. Because of this we hoped to improve and expand upon the existing literature. We especially wanted to document early and late reading measures in RR in adult L2 learners with an emphasis on expository reading in hopes that documented fluency gains will encourage ESL educators to implement RR as a fluency building exercise in the classroom. Our research questions were as follows:

1. How does immediate rereading of expository texts affect overall reading speed?
2. How does immediate rereading of expository texts affect early reading measures in adult ESL students in terms of skips, first run dwell time, first fixation duration?
3. How does immediate rereading of expository texts affect late reading measures in adult ESL students in terms of run count, regressions-in count, and late dwell time?

We expected that this study would support previous results, which have indicated that RR positively influences readers' fluency (e.g., Gorsuch & Taguchi, 2008; Boily, Ouellet, & Turcotte, 2015; Chang, 2012; Taguchi, Gorsuch, and Sasamoto, 2006; Nation, 2009; Chang & Millett, 2013). But we also expected this to go beyond by showing exactly where the readers eyes are looking and for how long, which will give insight into early and late reading measures that cannot be measured by self-timing alone. This study is designed to replicate the findings of Rich, et. al. (in process) with the examination of expository texts rather than narrative.

Methods

Participants

For this study we recruited 30 students from an intensive English program (IEP) in the United States. Students in the IEP took four 65-minute classes a day, four days a week in grammar, reading, writing, and listening/speaking. They were immersed in an ESL environment and many of them had intentions of studying at an American university and were therefore highly motivated to improve their English skills. The participants were adult English learners of both genders and multiple nationalities. Their ages were from 18 to 45 with an average age of 26. They were placed in intermediate-level classes in the IEP as a result of intensive proficiency exams based on ACTFL guidelines. Participants' native languages included Spanish (n = 11), Chinese (n = 8), Portuguese (n = 6), Russian (n = 2), Japanese (n = 1), Haitian Creole (n = 1), and French (n = 1). Several students reported some level of proficiency in other languages, including Malagasy, Swahili, Lingala, Tshiluba, and Italian. There were 13 males and 17 females.

Expository Passages

Expository texts are defined as texts meant to inform or educate with facts, or in other words "materials written to communicate information to help readers learn something new" (Sáenz & Fuchs, 2002, p. 31). We selected and modified three expository texts from *Encyclopedia of Animals, Faces,* and *Scholastic Scope* on the topics of caribou, the Loch Ness Monster, and Harriet Tubman (see appendix for a sample text). These are online magazines with readings designed for English-speaking children in grade school. The passages were abridged to approximately 270 words and modified to a Lexile measure of 800-900. This Lexile level was chosen because of the participants' intermediate English proficiency level and were similar to

texts they were using in the classroom. We wanted the passages to be at their reading level or slightly below for ease of reading. See Table 2 for a list of the measures controlled for in each text.

Table 2

Measures describing the distribution, frequency, and level of three expository texts used in the eye tracking study. The expository texts were about the Loch Ness Monster, Harriet Tubman, and Caribou.

Category	Measure	Loch Ness Monster	Harriet Tubman	Caribou
Distribution	Word count	268	271	264
	Type-Token ratio	0.5	0.6	0.5
	Lex density	0.5	0.6	0.5
Frequency	K 1000 words	79	80	78
	K 2000 words	6	8	10
	K 3000-4000 words	7	3	2
	K 5000+	3	0.4	3
	Off K lists	5	9	0.4
	AWL words	4	0.4	2
Level	Lexile measure	800L – 900L	800L-900L	800L-900L
	Mean sentence length	13	11	13
	Flesch Reading Ease	78	78	82
	Number of sentences	21	23	20

We submitted our texts to be analyzed for these measurements on the following websites: https://www.lextutor.ca/vp/comp, storytoolz.com/readability, https://lextutor.ca/vp/eng/, and https://la-tools.lexile.com/free-analyze/. We adjusted our texts by simplifying academic words and shortening sentences to make them easier, or the opposite to make them more difficult if needed.

Eye–Tracking Instrument

The adjusted expository texts were coded into areas of interest (AOIs) to be measured by the eye-tracking instrument. Each word in the text was coded to be an AOI so we could analyze exactly how long and how often each word was looked at during repeated reading.

The instrument used in this study is the SR Research EyeLink 1000 Plus located on Brigham Young University campus. The eye-tracking machine has a spatial resolution of 0.01° sampling at 1000 Hz (1° visual angle is about 3.5 characters and it takes 1000 measurements per second). For reference, eye-trackers range from 25-30 to 1000-2000 Hz in sampling frequencies. The computer screen that displayed the text was located 63 centimeters from the participant's head. Texts were displayed in 20-point monospaced Courier font, and lines were double-spaced.

Procedure

When a participant arrived at the eye-tracking lab they were seated in front of a computer screen and the attendant helped them comfortably adjust the forehead and chin rest to immobilize the head so eye-movements could be easily followed. The attendant then performed a 9-point calibration. Calibration was done as many times as necessary throughout the session to ensure accurate eye-tracking. The participant then read the expository texts prepared for the study as previously described. Each text was read three times in succession. A two-question comprehension quiz was given after the first reading of each passage and after the third reading of each passage. The comprehension quiz was to encourage the participants to read the texts carefully and to avoid skimming, although they were encouraged to read quickly. Our pilot study helped us determine that two questions were the maximum needed because more questions took too much time and we wanted the participants to be focused on reading the passages, not spending time taking a quiz. Participants were allowed short breaks as needed throughout the session to help them remain focused on the reading tasks. Calibration was performed after each break. Each session was approximately one hour long.

Analysis

We defined each word in the texts as areas of interest (AOIs) in order to examine eye-movements accurately at the word level in regards to words per minute, skips, first fixation duration, first run dwell time, run count, regressions-in count, and late dwell time. We visually inspected each data set and made small, manual adjustments to the eye-tracking data along the y-axis to match the spatial arrangement of text when the calibration was slightly off. We used repeated measures analysis of variance (RM ANOVAs) to analyze our collected data. Significance was determined when *p* values were less than 0.05. When significant effects between RRs were identified, we did pairwise comparisons among RRs using the post-hoc Tukey test. We used Cohen's parameters of magnitude of effect size (2016, p. 282), or η_p^2, as follows: 0.20 is small, 0.50 is moderate, and 0.80 is large. For each participant we calculated the average values of each measure for the first, second, and third readings of each text.

Results

The purpose of this eye-tracking study was to examine the effects of immediate repeated reading (RR) of expository texts on reading fluency in adult English language learners. The study was carried out with 30 intermediate-level students in an intensive English program in the United States.

Reading Speed

For our first research question we measured the immediate effect RR had on the overall reading speed of each participant. The RM ANOVA (Table 3) results were as expected and showed significant increase in average reading speed with each reading time ($F(2,58) = 76.4$, $p < 0.001$, $\eta_p^2 = 0.73$).

Our comparisons showed significant improvement with each reading. Participants read on average 13 seconds faster the second time than the first ($t(58 = 7.54, p < 0.001)$ and nine seconds faster the third time than the second ($t(58 = 4.71, p < 0.001)$. The total gain in reading speed was 22 seconds faster from time one to time three ($t(58 = 12.25, p < 0.001)$. To convert to the more recognizable measure of words per minute we divided the average number of words in the passages (270) by the seconds measured and multiplied by 60 (Figure 2).

Table 3

The means and standard deviation of reading speed in seconds for one, two, and three times expository texts were read.

	Time 1		Time 2		Time 3				
	Mean	SD	Mean	SD	Mean	SD	*F*	*p*	η_p^2
Duration of reading in seconds	53	16	40	13	31	12	76.4	<0.001	0.73

The words per minute may seem high for intermediate-level L2 readers, but this is influenced by the level of the texts and the instruction to the participants to read as quickly as possible while still understanding the meaning of what they read.

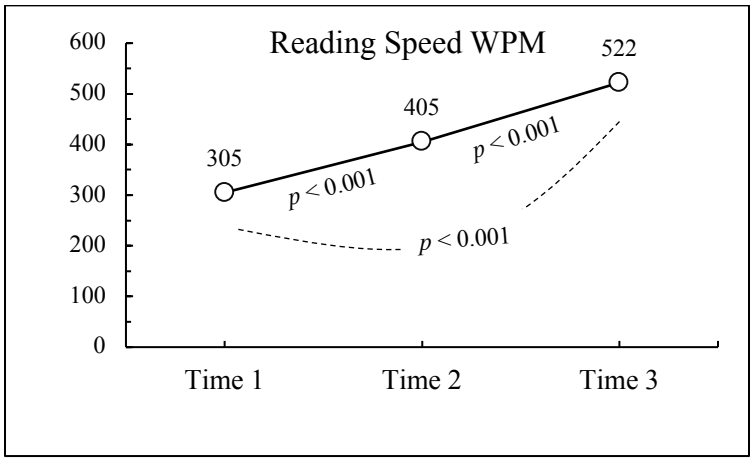

Figure 2. How reading an expository text one, two, or three times affects the reading speed of L2 readers in words per minute.

Early Reading Measures Results

Our next research question was regarding early reading measures (early measures correspond to lower-level reading processes), specifically how repeated reading affects skips, first fixation duration (FFD), and first run dwell time (FRD). These measures give insight into the automaticity of lower level processes that influence reading fluency (Table 4).

Table 4

Results for early and late reading measures for one, two, and three times expository texts were read. Early measures correspond to lower-level reading processes. Late measures correspond to higher-level reading processes.

	Time 1		Time 2		Time 3				
	Mean	SD	Mean	SD	Mean	SD	*F*	*p*	η_p^2
Skips	0.38	0.14	0.47	0.17	0.49	0.17	19.4	<0.001	0.40
First Fixation Duration (ms)	234	30	222	28.8	219	28.6	42.5	<0.001	0.59
First Run Dwell Time (ms)	312	52.5	275	41.6	263	41.3	93.5	<0.001	0.76
Run Count	1.09	0.21	0.90	0.21	0.75	0.16	42.9	<0.001	0.60
Regression-in Count	0.21	0.12	0.20	0.11	0.16	0.10	25.9	<0.001	0.47
Late Dwell Time (ms)	288	56	265	57.7	247	49.3	9.46	<0.001	0.25

Skips is a measure of whether a word was skipped (1 or 0) during first-pass reading. Skipping suggests little effort was needed to understand the word as it was most likely viewed in the periphery of the previous word and was easily recognizable or predictable (Rayner, 2009). The participants increased their average skips with each rereading of the text ($F(2, 58) = 19.4$, $p < 0.001$, $\eta_p^2 = 0.40$). There were on average 0.09 more skips per word between the first and second reading ($t(58) = -4.88$, $p < 0.001$), and 0.11 more skips per word between the first and third reading ($t(58) = -5.79$, $p < 0.001$). There was not a significant difference between the second and third readings. In other words, the first time through 3.8 out of every 10 words were

skipped, the second time slightly less than 4.7 out of 10 words were skipped, and the third time nearly 4.9 out of 10 words were skipped (not a significant change from the second read-through). This indicates that with each successive reading, more words were easily recognizable and there was not a need to fixate on them (Figure 3).

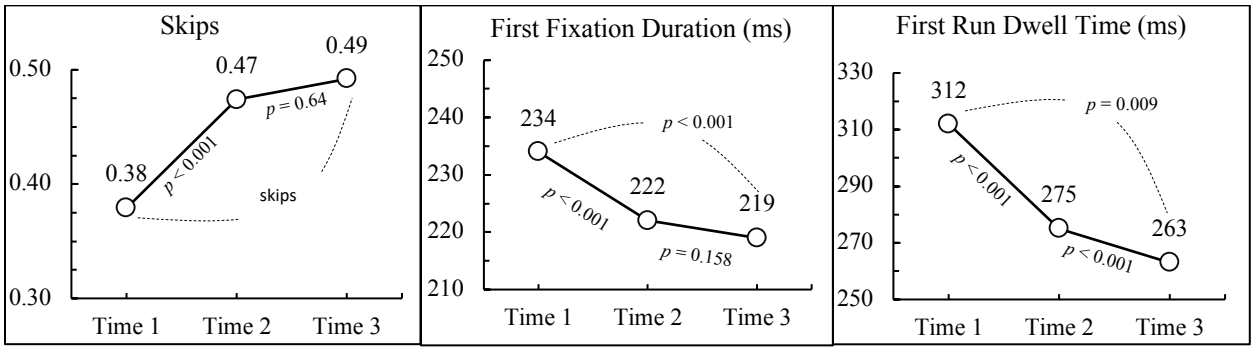

Figure 3. How reading an expository text one, two, or three times affects early reading measures.

First fixation duration (FFD) is the measure in milliseconds of the amount of time a reader spends on their initial fixation of a word if the word isn't skipped initially. FFD shows the processing time required for letter and early word recognition, and indicates automaticity (Holmqvist, et. al., 2011). The more time spent on the first fixation suggests less automatic word recognition. The RM ANOVA for FFD was significant ($F(2, 58) = 42.5$, $p < 0.001$, $\eta_p^2 = 0.59$). Our comparisons showed that FFD significantly decreased on average by 13 milliseconds from the first to the second reading ($t(58) = 6.89$, $p < 0.001$) and by 15 milliseconds from the first to the third reading ($t(58) = 8.79$, $p < 0.001$). However, the change from the second to the third reading was only three milliseconds and was not significant ($t(58) = 1.87$, $p = 0.16$).

First run dwell time (FRD) is the final early reading measure we analyzed. FRD is the total amount of time in milliseconds that a reader spends on the first pass of a word from entry to exit if the word isn't skipped initially. This has been described as possibly a more accurate measure of early reading processes than FFD because the total FRD could include several

fixations on the same word indicating the need for more attention to semantically challenging structures (Holmqvist, et al. 2011). The participants significantly decreased their FRD with subsequent readings of the text ($F(2, 58) = 93.5$, $p < 0.001$, $\eta_p^2 = 0.76$). The RM ANOVA showed significant results between all three readings of the text. The FRD was on average 37 milliseconds less from the first to the second reading ($t(58) = 10.02$, $p < 0.001$) and 49 milliseconds less from the first to the third reading ($t(58) = 13.07$, $p < 0.001$). The FRD was 12 milliseconds less from the second to the third reading, which was also significant ($t(58) = 3.05$, $p = 0.009$).

Late Reading Measures Results

Our final research question was concerned with how RR affects late reading measures (late measures correspond to higher-level reading processes), specifically run count, regressions-in count, and late dwell time. These measures give insight into the effort required for higher reading processes that involve comprehending what is being read (Figure 4).

The run count is the total number of times that a reader reads through a word. It can indicate the amount of effort needed to comprehend the word and the context within the sentence. The RM ANOVA showed a significant decrease in run count between all three readings of the text ($F(2, 58) = 42.9$, $p < 0.001$, $\eta_p^2 = 0.6$). The average difference was 0.19 runs per word between the first and second readings ($t(58) = 5.06$, $p < 0.001$) and 0.34 runs per word between the first and third readings ($t(58) = 9.24$, $p < 0.001$). The average difference between the second and third readings was 0.15 runs per word ($t(58) = 4.18$, $p < 0.001$).

Regression in count measures the amount of times readers looked back (from right to left) at a previous word. Regressing back to a word after a first run indicates processing difficulty (Conklin, Pellicer-Sanchez, & Carroll, 2018). Our data showed significantly less regressions

with RR ($F(2, 58) = 25.9$, $p < 0.001$, $\eta_p^2 = 0.47$). There were on average 0.06 fewer regressions from the first reading to the third reading ($t(58) = 6.66$, $p < 0.001$) and 0.05 between the second and third readings ($t(58) = 5.7$, $p < 0.001$) which are both significant. There was not a significant change from the first to second readings ($t(58) = 0.1$, $p = 0.6$).

The late dwell time (LDT) is an insightful factor in looking at late reading processes. It is the total dwell time less the first run dwell time. Late dwell time is longer for words that require more effort or provide more information to context (Holmqvist, et al., 2011). The RM ANOVA for LDT was significant ($F(2, 58) = 9.46$, $p < 0.001$, $\eta_p^2 = 0.25$). The difference between the first and second readings ($t(58) = 2.44$, $p = 0.05$), and the second and third readings ($t(58) = 1.9$, $p = 0.15$) was not statistically significant. However, the difference between the first and third readings was 40 milliseconds ($t(58) = 4.34$, $p < 0.001$) which is significant.

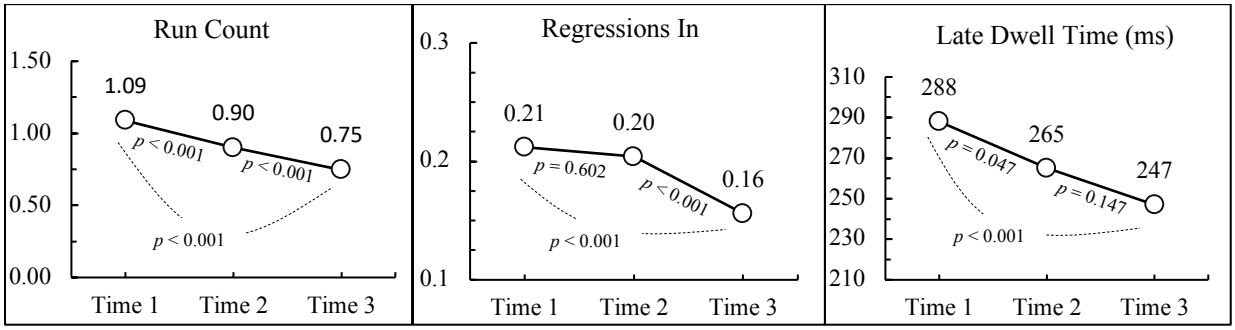

Figure 4. How reading an expository text one, two, or three times affects late reading measures.

Discussion

The purpose of this study was to gain a greater understanding of the effect of immediate RR on reading fluency with adult English language learners. The benefits of RR have been well-documented in many L1 studies, but the research is limited with L2 adult learners. Eye-tracking provided additional insight by using exact measures of the eye gaze and duration when reading. We found that immediate RR significantly impacted the overall reading speed (WPM) and both

early reading (e.g. word recognition) and late reading (e.g. text integration strategies) with each reading of the text. We expected to see improvement in measures indicating an increase in reading fluency with RR and we were not surprised by the results. This supports the findings of previous studies of RR in L2 settings which showed increased reading fluency over several weeks of RR treatment using self-timing measures (Taguchi, 1997; Taguchi & Gorsuch, 2002; Taguchi, Takayasu-Maass, & Gorsuch, 2004; and Gorsuch & Taguchi, 2008). Our study showed increased reading fluency through RR in a one-time setting with the accuracy of eye-tracking equipment recording the reading speed of the participants. The immediate RR eye-tracking study of narrative texts by Rich, et. al. (in process) also found significance in each of the six eye-tracking measures used to document the impact of RR on reading fluency, and therefore our results were as expected.

The increase in reading speed of words per minute was quite dramatic. The first time they read a text the participants read on average 302 WPM and by the third reading of the text they averaged 522 WPM. This seems extremely fast for intermediate-level L2 readers, but can be explained by our careful control of the chosen expository texts which were tailored to be at, or below the level of the participants' reading abilities. The participants were reading at a level in which the words were familiar enough that they were already automatically processed in support of Automaticity Theory. The participants were also encouraged to read faster each time while still understanding the text. They read on average 25% faster between the first and second reading and 22% faster again between the second and third reading. This shows that RR is highly effective as an immediate exercise for increasing fluency, but we did not study whether these gains could be transferred to new passages.

The early reading measures of skips, first fixation duration (FFD), and first run dwell time (FRD) all showed increased automaticity with RR. The greatest change for skips and FFD was seen between the first and second readings; the difference between the second and third readings for these measures was not significant. This means there were significantly less words fixated on and less time spent on the first look at a word between the first and second readings. One possible explanation for the lack of change between second and third reading is that the participants reached a threshold in decoding and early word recognition and could not get much faster the third time. These findings support the findings in the RR eye-tracking study of Rich, et. al. (in process) with narrative texts except that in their study each reading time was significant.

The third early reading measure, FRD, had the greatest effect size of all our measures ($\eta_p^2 = .76$) and was significant between all three readings. As stated before, this measure is probably the most impactful for showing improved automaticity with each reading because it is the total amount of time spent on a word the first time it is encountered (which may include multiple fixations). The improvement shown is in support of Automaticity Theory; as the participants practiced reading with the RR method, the lower-level processes became more automatic leading to greater fluency with each read-through. This should be encouraging for teachers as it shows that with each repeated reading of the text, students can significantly decrease the amount of time they spend on the first reading of a word. The reading is becoming more automatic each time through and therefore more fluent.

Overall late reading measures—run count, regressions-in, and late dwell time (LDT)—showed significant improvement with RR. Later reading measures show more deliberate strategizing as readers returned to words or sentences that required more time for understanding. Run count significantly decreased each time the text was read. However, regressions-in did not

show significant improvement between the first and second readings suggesting that more repeated reading could lead to higher gains in this measure. It is possible that the first and second times through there were similar regression numbers because they were still integrating the text and needed to go back and re-read, but by the third time they no longer needed to go back as much. LDT is an interesting measure because it isolates the total amount of time spent on a word after the first pass. This measure had the smallest effect size in our study ($\eta_p^2 = 0.25$) but was still significant. The measurable improvement in LDT occurred from the first to the third reading. This again indicates that three readings may be necessary for improvement in automaticity of higher reading processes.

These results support the findings of the eye-tracking study on narrative readings of Rich, et. al. (in process). Our results also show support for Verbal Efficiency Theory in that later reading skills can be developed with practice and become more automatic, especially with at least three repetitions. Meaningfully, our study supports both Automaticity Theory and Verbal Efficiency Theory and suggests that with RR both early and later reading skills can be developed simultaneously in an immediate RR environment.

Conclusions and Future Research

The purpose of this study was to examine what effect RR of expository texts had on adult ESL students' reading fluency. The overall results were significant on every measure showing that immediate RR has positive effects on both early and late reading skills supporting both Automaticity Theory (e.g. lower-level reading skills such as word decoding must become automatic in order for readers to have the mental capacity to ascribe meaning to the text) and Verbal Efficiency Theory (e.g. higher-level reading skills readers use strategically for text comprehension can also become automatic). The pairwise comparisons of late reading measures

showed that at least three readings of the texts were necessary for improvements in higher-level reading skills that involve text integration, or comprehension.

These immediate results in a one-time RR activity should be encouraging for instructors because of the evidence that RR shows concrete improvement of reading speed with a single text in a one-time setting. English language learners could potentially see an immediate benefit by an increase in their reading fluency and become more aware of the importance of reading practice. We did not design this study to demonstrate whether these fluency gains transfer to new readings, but there is room for more study.

Several limitations to this study open opportunities for further research. This study was a one-time repeated reading exercise with no follow up or continuation in a classroom. This study also did not account for the participants' native language background where those whose L1 uses a non-Roman script may have a comparably different outcome. All the participants come from and IEP where reading fluency, including RR, is emphasized and therefore the results may not be generalizable. We did not question the participants to find out if they were previously familiar with the topics or vocabulary presented in the expository texts. This study did not focus on comprehension, which is a strong outcome of reading fluency, but only used comprehension questions to encourage thorough reading of the texts. Some of the previous research included audio-assist and more repetitions, so there is potential for more eye-tracking studies that include these measures (Blum et al., 1995; Taguchi, 1997; Taguchi and Gorsuch, 2002; Taguchi, Takayasu-Maass, and Gorsuch, 2004; Gorsuch & Taguchi, 2008). Oral repeated reading is another reading activity to explore with eye-tracking. Our study showed favorable improvement in reading fluency with three repetitions, but would the positive trend increase with more readings? Other areas of future research could include using different proficiency levels of L2

participants, different levels of texts, focus on different nationalities or languages, and/or using overlapping vocabulary to see if there is immediate improvement in reading measures from one text to the next. There are many opportunities for further exploration.

Our research on RR has implications for both language acquisition theorists and English language instructors. Our study has shown positive support for Automaticity and Verbal Efficiency Theories backing up the idea that word recognition and higher-level reading strategies can become more automatic in an immediate RR activity. The advantages to this practice are great and the positive outcomes could help improve English language learners' potential to be successful in an academic setting, or in timed test taking situations. Repeated reading has demonstrated benefits for English language learners in developing immediate fluency and therefore is recommended to be utilized regularly by reading and language teachers as an activity to help increase reading fluency.

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Appendix

Sample Reading Text

This text was adapted from an entry in *Encyclopedia of Animals* (Caribou, 2017).

Caribou are large members of the deer family. They are similar to reindeer, except reindeer live in a different part of the world and have been domesticated. Domesticated means that people have trained and raised them for specific purposes. Caribou cannot be domesticated and so remain wild.

Caribou have long bodies and legs. Their hooves are broad for firm footing on soft ground, snow, and ice. Their fur coats change from brown in the summer to gray in the winter. This helps the caribou to blend in with their surroundings and protect them from predators. Their fur is thick and waterproof. Caribou have fur on their muzzles, or nose and mouth, to help keep them warm. They do not see well, but their good sense of smell makes up for their poor vision.

Caribou and reindeer are the only members of the deer family in which both males and females have antlers. Their antlers have several points like branches. Male antlers may have up to 44 points on them and are very large. Both males and females shed (lose) their antlers each year and grow new ones. The new antlers are larger than the ones they replaced. Antlers are very important during mating season because the males fight to mate with females. Their antlers are used as weapons and often become damaged in the fierce fights. If the male did not lose his antlers and grow a new set each year he would not be able to fight as well. Without good, strong antlers he will lose fights and not be able to mate.

Sample Comprehension Questions

The asterisks indicate the correct response.

1. What is the main idea of this reading?
    a. to teach about caribou*
    b. to teach about caribou being trained by people
    c. to describe places that caribou live
    d. to teach about the antlers of the caribou
2. The word “domesticated” means _____.
    a. trained to be used by people*
    b. animals that live in the wild
    c. comfortable in the house
    d. small and covered with fur