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The Effects of Repeated Reading on the Fluency of Intermediate-Level English-as-a-Second-Language Learners: An Eye-Tracking Study

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ABSTRACT

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Most would agree that reading fluency is a concern of every L2 teacher. Repeated reading (RR) positively affects fluency development, supported by much research with L1 children. However, relatively little focus has been given to L2 RR. Most research on RR in L2 settings has focused on audio-assisted RR, used insufficient data collection methods prone to human error, and taken place in an EFL setting. In our experiment, we used eye–tracking as a direct mode of measurement of the effects that RR has on early and late reading measures. In this study, 30 intermediate-level English language learners studying in an intensive English program in the United States participated. Participants silently read three carefully leveled narrative texts, three times each. As they read each passage, an eye–tracking machine gathered data on their eye movements. With immediate repeated exposure to the texts, students improved their reading fluency in both early and late measures of reading.

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

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Introduction

In 1998, the National Reading Panel (NRP) compiled a meta-analysis of over 100,000 empirical reading studies. After reviewing these studies, the NRP concluded that repeated reading (RR), or reading the same text multiple times, improved children's reading fluency with almost no exceptions (Grabe, 2010). It would seem, then, that RR is worthy of attention from educators, students, and researchers alike.

Fluency, in its simplest form, is reading rate, accuracy, and comprehension. Generally speaking, RR may be defined as the process in which "L2 learners read specified passages... repeatedly in order to increase learners' sight recognition of words and phrases, resulting in increased fluency" (Taguchi, Takayasu-Maass, & Gorsuch, 2004). RR implies that a student reads a text at least three times until a fluency threshold is reached (Samuels, 1979). Chang and Millett (2013) offered a similar definition of RR: "rereading short passages several times until a satisfactory rate is reached" (p. 128). Therrien (2004) requires that RR texts should be read three or four times.

Samuels (1979) and Dahl (1979) introduced RR to aid children with reading difficulties in their L1, believing that RR would increase readers' fluency as they improved their ability to recognize words rapidly. One purpose of RR "is to give the student the opportunity to master the material before moving on" (Samuels, 1979, p. 407). The original process of RR included these steps: First, students read a series of short passages until they are able to orally read 100 words per minute (WPM) correctly; after reaching that level, students move on to a new passage; finally, as students become more familiar with the RR method, they require less repetition before successfully reaching the desired level (Taguchi, Gorsuch, Lems, & Rosszell, 2016, pp. 105–106).

RR has been used to increase the fluency of both native speakers of English and learners of English as a foreign language (EFL). It should be noted, however, that different studies involve various methods of RR and may interpret fluency in differing ways.

Review of Literature

The entire premise of RR is built upon the idea that it improves reading fluency, which itself has been defined in many ways by different researchers over the years (e.g., Meyer & Felton, 1999; Freeland, Skinner, Jackson, McDaniel, & Smith, 2000; Clay, 1969). Grabe (2009) has defined reading fluency as "the ability to read rapidly [250–300 words per minute] with ease and accuracy, and to read with appropriate expression and phrasing" (p. 72). Similarly, fluency has been described as the combination of "accuracy, automaticity, and oral reading prosody"; together, these principles ease the process for a reader to create meaning from a text (Kuhn, Schwanenfluegel, and Meisinger, 2010). Kuhn and Stahl (2003) emphasize that, although decoding accuracy and reading rate are two elements of fluency, prosody plays a crucial role in fluency, and indeed, students' rate of oral reading is often used as a means of measuring fluency (Meyer & Felton, 1999).

Many studies have focused on native English-speaking children learning to read in their first language (L1). For instance, Kuhn (2004) states that building students' reading fluency is of primary importance for the same reasons mentioned above: Fluent readers are able to decode text automatically and accurately, read with appropriate prosody, and "construct meaning from text" (p. 338). One purpose of Kuhn's study was to determine the effects of fluency-oriented RR on 24 second graders' reading fluency. Kuhn found that RR participants improved their fluency in terms of automaticity, prosody, and accuracy.

In an effort to study fluency as it relates to context, Jenkins, Fuchs, van den Broek, Espin, and Deno (2003) conducted research involving 113 fourth graders. Students read out loud for one consecutive minute while research assistants counted the number of errors and non-errors in participants' reading. The text was presented in three different ways: contextual, in its original format; listed, in which students simply read the words of the text from a scrambled list; and random, in which the words were randomly reordered into paragraphs and the punctuation was deleted. Fluency was measured according to accuracy, reading speed, and reading time (p. 721). Jenkins et al. (2003) concluded that context fluency can be used as an estimator of overall reading comprehension, but simple list fluency cannot be used so reliably.

Therrien and Kubina (2006) advocate for RR as a means of improving reading fluency. They offer suggestions for the implementation of RR into the classroom. "Regardless of present grade level," they counsel, "[RR] appears beneficial for students who read between a first- and third-grade instructional level… [or] for students who, although able to decode words above a third-grade level, read in a slow, halting manner" (pp. 156–157). The authors also indicate that several research bases have been covered with RR, citing a number of previous studies that investigate RR as an assistive tool for students with and without learning disabilities, autism, low vision, and low reading ability. Indeed, many studies have utilized RR in these contexts (e.g., O'Conner, White, & Swanson, 2007; Meyer & Felton, 1999). However, Samuels (1979) adds, "While the method is particularly suitable for students with special learning problems, it is useful for normal children as well" (p. 403). It is true that both readers with learning disabilities and readers without have experienced overall improved L1 fluency (Therrien, 2004).

Freeland, et al. (2000) set out to determine whether reading comprehension could be improved through RR. Using oral RR as a measure of reading fluency, they concluded that RR had some positive effects on L1 students with a specific reading learning disability; the students' factual comprehension increased.

In addition to studies that have focused on struggling L1 readers, limited RR research has focused on language minority (LM) students. Crosson and Lesaux (2010) built upon previous *monolingual* fluency research (e.g., Jenkins et al., 2003) to conduct their study with LM Spanish–English readers. The reading fluency of participants, who were fifth-grade Spanish-speaking LM students, was greatly associated with their comprehension.

Despite the positive results of RR with L1 readers, Taguchi, Gorsuch, and Sasamoto (2006) claim that significantly less attention has been paid to adult second language (L2) readers (e.g., Gorsuch & Taguchi, 2008; Boily, Ouellet, & Turcotte, 2015; Chang, 2012; Taguchi, Gorsuch, and Sasamoto, 2006; Nation, 2009; Chang & Millett, 2013). Gorsuch and Taguchi (2010) suggest that this may be because teachers don't realize that RR has such positive implications. Another possibility is that teachers view RR as an inefficient use of class time, even though the few studies that do examine RR for the L2 classroom have shown similar positive effects on fluency. Furthermore, the increased complexity of L2 reading (compared to L1 reading) mandates further consideration.

One of the first L2 RR studies took place in 1995. Blum, Koskinen, Tennant, Parker, Straub, and Curry (1995) conducted a 19-week experiment, in which first-grade English as a second language (ESL) speakers participated in a form of RR at home. Using weekly measures and periodic assessment tasks, the authors concluded that participants benefitted from RR. Furthermore, the students, parents, and teachers generally felt positively about the practice, and teachers noted that in addition to increased reading fluency, the students also increased in independence and confidence.

We find support for these claims in Dlugosz (2000). Young ELLs listened to a story in class before listening to it twice more daily in their homes over the course of ten days. The students listened to the story in class multiple times and participated in engaging activities to demonstrate their understanding of the text. Then, the students followed along with the written text and were encouraged to read aloud with the teacher. After repeating this cycle multiple times, the children were able to read the book on their own. The children who participated in these activities "had virtually no problem in reading texts they had never seen before, but which were composed out of phrases and vocabulary they had already been taught" (p. 288). This suggests that not only does RR contribute to reading fluency within a particular text, but RR also has the potential to improve students' reading fluency across related texts.

Further previous research supports the hypothesis that RR leads to increased fluency. In many cases, study participants who received RR treatment showed significant fluency gains from initial readings to final readings. For instance, in Japan, 15 university students, almost exclusively female, who spoke EFL participated in a RR treatment in 28 thirty-minute sessions. In each session, students reviewed what they had read in the previous session and then read a new passage. They read the new passage once silently, three times while listening to an exact audiotaped version of the text, and three more times silently. Hence, the students read each passage seven times within a single session. The RR treatment significantly improved readers' silent reading rates, suggesting that giving students plenty of opportunities to read repeatedly allows them to continuously increase their reading rates (Taguchi, 1997).

In another study, nine first-year university Japanese EFL learners participated in RR over 20 sessions. The session procedure followed the same parameters as those set forth in Taguchi (1997). During the silent reading, participants were asked to read as quickly as possible while still understanding the meaning of the text. The students' silent reading rate increased significantly from the pretest to the posttest. Additionally, the authors noted, "It is interesting...

how much FL readers… can improve their reading comprehension when they read repeatedly" (Taguchi and Gorsuch, 2002).

Building upon Taguchi and Gorsuch's (2002) study, Taguchi, Takayasu-Maass, and Gorsuch (2004) investigated the effects of RR. Over the course of 17 weeks and 42 RR sessions, ten Japanese university students learning EFL participated in RR treatment. In total, the participants read 57 pages, five times each; some of the RR was silent, and some was supplemented with an auditory model. Within each session, as well as over the course of the treatment, the students increased their WPM significantly. Furthermore, most participants seemed to appreciate this effect, reporting positive perceptions of the RR exercises.

To apply the RR treatment to greater contexts, another study included 50 EFL university students in Vietnam, 24 of whom participated in an RR procedure. In the treatment, the participants read each text once silently, twice with audio-assist, and two more times silently. After the readings, participants wrote a report about the texts. As with the previous three studies that took place in Japan, a within-group statistical analysis revealed that the Vietnamese participants saw significantly increased reading rates (Gorsuch & Taguchi, 2008).

Though they did not test for within-group significance, Chang and Millett (2013) reported that RR participants increased their WPM. In Taiwan, 13 university students learning EFL participated in the 13-week treatment. During each session, they read each passage five times, timing their readings and answering comprehension questions after the first and final readings.

These studies have generated optimism regarding RR. However, we note several major limitations that we desired to build upon. First, much L2 RR research takes place in EFL settings. Specifically, it involves ELLs from an Asian L1 reading script in Roman letters. Adult learners are more metacognitively and strategically aware, so they may see greater gains in a text-rich L2 setting, such as an ESL environment. An ESL environment includes nations where English is the primary language spoken. Taguchi (1997), Taguchi and Gorsuch (2002) and Taguchi, Takayasu-Maass, and Gorsuch (2004) all took place in Japan; Gorsuch & Taguchi (2008) in Vietnam; and Chang and Millett (2013) in Taiwan. EFL settings have developed a firm foundation in adult RR research, but the ESL environment has been neglected.

Additionally, much previous RR research has utilized Samuels's original RR model with auditory modeling of the text (see, for example, Blum et al., 1995; Taguchi, 1997; Taguchi and Gorsuch, 2002; Taguchi, Takayasu-Maass, and Gorsuch, 2004; Gorsuch & Taguchi, 2008). Unfortunately, there is significantly less evidence that ELLs' exclusively silent RR of a text poses optimistic results (see, for instance, Chang and Millett, 2013).

Overall, previous RR studies have concluded that readers can increase their rate as a result of RR, which provides insight into the benefits of RR on oral fluency. While these are positive conclusions, we were interested in which specific reading processes are affected by RR. Why does RR improve fluency? Do readers look at individual words for less time? Do they make fewer fixations per word? Do they return to words less frequently? Do they skip over more words? We were concerned with identifying whether early or late, or both, reading processes are the cause of increased fluency.

Clearly, there are many gaps in the existing L2 RR literature. In an effort to minimize these gaps, we recruited adult ESL students to participate in a single silent RR session lasting about 60 minutes. Our findings enhance our understanding of language learning theories, produce implications for the ESL classroom, and may inform future RR studies. Additionally, unlike all previous research dealing with L2 reading fluency, we used eye–tracking technology to gather precise measures neglected by previous research.

Rationale behind Eye–tracking

Previous research has relied on mostly indirect measures, such as self-reported reading speeds, which are highly susceptible to human error. Previous RR participants manually timed themselves with a stopwatch and recorded their reading times and number of repetitions (Taguchi, 1997; Taguchi and Gorsuch, 2002; Taguchi, Takayasu-Maass, and Gorsuch, 2004; and Gorsuch & Taguchi, 2008). Chang and Millett (2013) projected an online stopwatch so students could record their own reading times.

We were more interested in the fine details of reading fluency. The use of self-timing disregards a plethora of fine measurements that provide insight into fluency for both early and late reading measures. Previous research has used reading time as a proxy for decoding time, but eye–tracking can measure decoding much more accurately than a stopwatch, providing insight into which reading processes are causing overall fluency improvement. Figure 1 shows a visual representation of the relevant eye–tracking measures.

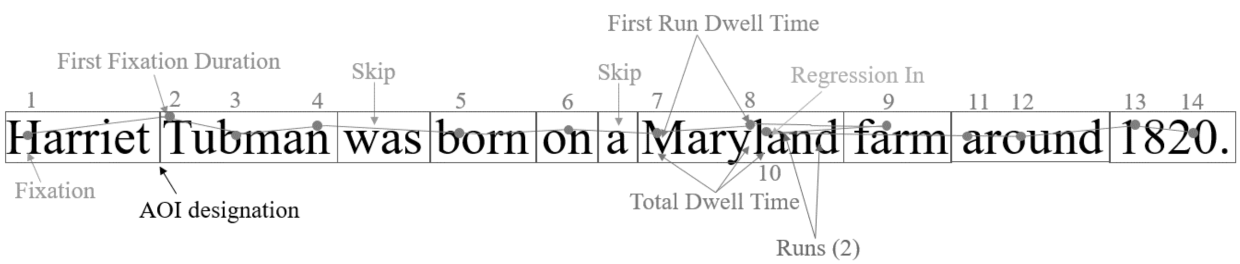

Figure 1. A visual representation of eye–tracking measures.

As shown in Figure 1, a fixation is a direct stop over a word. Multiple fixations can occur on a single word. Of course, some words may not be fixated on at all during a first pass. When a reader does not fixate on a particular word in the first pass, this is known as a skip, even if the reader fixates on that word in a later pass. Rayner, Sereno, Morris, Schmauder, & Clifton (1989) suggest that words with three or fewer letters are often skipped, while longer words are not. Additionally, function words are more likely to be skipped than content words. It is also necessary to note that skipped words are likely perceived and processed during the fixation immediately preceding the skipped word, inflating the fixation duration of the preceding fixation.

First fixation duration (FFD) is a measure of early decoding and letter recognition and indicates a student's initial interaction with the word, specifically the lexical activation process (see Holmqvist, Nyström, Andersson, Dewhurst, Jarodzka, and van de Weijer, 2011). FFDs are measured in milliseconds. Longer FFDs indicate more difficulty with word recognition or decoding of a letter. Shorter FFDs indicate more familiarity with a word or predictability of that particular word in a sequence. Thus, it is expected that as students reread a text, they develop more fluency, which translates to overall shorter FFDs. We cannot measure FFDs without an eye–tracker because students are unable to self-report FFDs in milliseconds.

First run dwell time (FRD) is the total amount of time in milliseconds that a student spends on a word during the initial pass over that word. When a reader's gaze moves out of an area of interest (AOI), which in our study signifies any single word, the first pass is complete (Rayner et al., 1989). For instance, in Figure 1, the reader fixated on the word *Maryland* twice during the first pass. The FRD is the number of milliseconds the reader spent on the first and second fixations. This calculation does not include the third fixation, which occurred during the second pass of the word *Maryland.*

The preceding three measures are involved in the process of decoding, which is an early reading process. In addition to skip count, FFD, and FRD, we collected three other measures.

The following three measures are involved in late reading processes. As aforementioned, the following measures were used as a proxy for comprehension, or "the process of simultaneously extracting and constructing meaning through interaction and involvement with written language" (RAND Reading Study Group, 2002, p. 7).

Consider the word *Maryland* in Figure 1 again. We noted that the FRD included only the two fixations that occurred during the first pass over the word. However, the reader fixated on the word a third time, after the first pass. The sum of all of a word's fixations is the total dwell time (TDT). In general, dwell time "indicates interest in an object, or higher informativeness of an object... A higher dwell time may be indicative of uncertainty and poorer situation awareness" (Holmqvist et al., 2011, p. 387). Thus, a longer dwell time suggests more difficulty integrating the word into the overall meanings; this is why later reading measures, such as TDT, can stand in as a measure of comprehension speed.

Run count is the sum of all passes a reader makes on a word. Run count can inform us about the amount of attention required for a reader to comprehend a word. For instance, if a reader reads the word *Tubman* once and then returns to it a second time, but reads the word *Harriet* only once, it is likely that the reader did not require as much attention to process the word *Harriet* as he did *Tubman.*

Finally, regressions in are the phenomenon that occur when a reader looks back into a previous AOI. In our example, the reader had passed through *Maryland* and continued on to *farm* before returning again to *Maryland.* Conklin, Pellicer-Sánchez, and Carrol (2018) explain that regressions in may indicate "the subsequent time taken to overcome that difficulty [of a recently encountered word]" (p. 67).

As a general summary of the measures, the longer a reader fixates on a word, the more time necessary to comprehend the word (see Conklin, Pellicer-Sánchez, & Carrol, 2018); the more a reader skips over words, the less time and attention required for comprehension; and the more a reader regresses in to a prior AOI, the more time and attention required for comprehension.

These brief definitions and discussion are sufficient for current purposes, but refer to Rayner (1998) and Rayner et al. (1989) for more in-depth descriptions of eye–tracking measures. For a summary of these descriptions, see Table 1.

Table 1

Eye–tracking Measures, Definitions, and Purposes

Eye–tracking measure	**Definition**	**Purpose**
Skip count	The number of times that a reader skips over a word during the first pass.	May indicate a lack of need to spend time decoding the word.
First fixation duration	The amount of time in milliseconds that a reader spends on his initial fixation of a word.	Informs us about the time required for immediate word recognition.
First run dwell time	The amount of time in milliseconds that a reader spends collectively on all first-pass fixations of a given word.	Informs us about the total time required for word recognition.
Total dwell time	The amount of time in milliseconds that a reader spends on all fixations of a word.	Provides insight into comprehension.
Run count	The total number of times that a reader fixates on a word.	Informs us about the amount of attention required for a reader to comprehend a word.
Regressions in count	The total number of times that a reader regresses to (looks back at) a word.	May indicate confusion or a need for clarification.

These measures can give us insight into students' reading fluency. For the sake of this study, the term *reading fluency* focused primarily on automaticity in decoding. Additionally, we used certain eye–tracking measurements as a proxy for comprehension. Previous definitions of fluency have included oral prosody; however, given that ELLs are still developing their oral skills, and therefore oral prosody may not provide accurate insight into their true reading abilities, we have chosen to exclude this element from the study. Instead, we have attained a visual representation of students' fluency through eye–tracking.

Theoretical Frameworks

Though literate individuals may not even realize it, reading is highly complex. No matter the genre of a text, reading entails various mental and physical processes that do not come naturally (Zadina, Smilkstein, Daiek, & Anter, 2014), such as automatically recognizing visual and aural components of a word (e.g., letters, sounds, and word parts; Logan, 1997), and accurately linking a word to its definition (Grabe, 2009).

Reading in a second language is an especially complex process; readers must activate and apply their reading abilities and knowledge (e.g., vocabulary, grammar, culture, etc.) from their L1 to the L2. When ELLs encounter infrequent words in L2 reading, they rely on past experience with the word or related words. The more often a person is exposed to a particular word, the more quickly he will process the word in subsequent exposures; this is the word frequency effect (Cop, Keuleers, Drieghe, & Duyck, 2015). The more familiar a reader becomes with a word, the more quickly he will be able to access it in his mental lexicon. Hence, repeated exposure and reading fluency are connected.

This ideology aligns with the automaticity theory, the first major theoretical framework surrounding reading fluency. LaBerge and Samuels (1974) theorized that the more quickly and accurately a reader manages lower-order reading processes (i.e., decoding), the more cognitive space he has available to deal with higher reading processes (i.e., comprehension; Therrien, 2004). If the word frequency effect holds true, repeated exposure to a word means quicker and more accurate decoding and an increased capacity to comprehend. In other words, it means improved fluency. This is the automaticity theory (AT). Because lexical and syntactic familiarity influence reading fluency, readers can improve their fluency by more frequent exposure to words and grammar. In fact, Samuels (1979) first introduced RR as a means of applying AT to practical use.

Informed in part by AT, Perfetti (1985) proposed the verbal efficiency theory (VET), which assumes "that the amount of attention required is modifiable by processing experience… [and] to the extent that lexical access is resource efficient, the encoding of propositions in working memory can be achieved more efficiently" (pp. 101, 103). That is, the more experience a reader has with reading, the lower the demand is on local processes such as decoding, and the more resources there are available for comprehension.

The contrast between the two theories is this: AT claims that decoding and comprehension compete for mental attention, and when decoding decreases, comprehension can then increase. VET says that decoding and comprehension do not necessarily compete with one another, but they are related in the sense that more efficient decoding supports better comprehension (see also Kendeou, Papadopoulos, & Spanoudis, 2012). Furthermore, VET claims that not only can the lower-level reading processes become more automatic through extensive practice, but the higher-level processes can, as well (see Taguchi, Gorsuch, & Sasamoto, 2006).

Motivated by Perfetti's VET, we were interested in whether both lower- and higher-level processes can be taught (or at least increased) through an intervention of repeated exposures to text. As mentioned previously, self-timing procedures have not been sufficiently granular to determine the effect of intervention on the specific processes of reading fluency. An eye–tracker, however, is fine-tuned enough that it allows for the measurements of decoding speed (early reading) and comprehension processes (late reading). Table 2 summarizes the relationship between eye–tracking measures and early and late reading.

Table 2

Classification of Eye–tracking Measures According to Reading Process

Early reading measures	**Late reading measures**
Skip count	Total dwell time
First fixation duration	Run count
First run dwell time	Regressions in count

If intervention can indeed improve both decoding and comprehension time, then VET holds true. However, if decoding remains constant while later reading processes speed up, then we can speculate that decoding is not necessarily related to comprehension. In this case, we may surmise that ESL readers hit a maximum decoding speed that they cannot move beyond even when later processes speed up.

Motivation and Research Questions

As the English language continues to grow in prominence in educational systems, the work force, and the world, the number of adult ESL learners will surely continue to rise. Because of this, we found that it was appropriate to expound and improve upon the existing literature. Specifically, we hoped to view AT and VET in a new light. Therefore, the research questions in this study are as follow:

(1) How does narrative rereading behavior affect early reading measures in adult ESL students in terms of

(A) skip count,

(B) first run dwell time, and

(C) first fixation duration?

(2) How does narrative rereading behavior affect late reading measures in adult ESL students in terms of

(A) total dwell time,

(B) run count, and

(C) regressions in count?

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).

Methods

Participants

Thirty ELLs currently studying at the English Language Center (ELC) at Brigham Young University participated. The ELC is an intensive English program with the following levels: Foundations A (mid-novice), Foundations B (high-novice), Foundations C (low-intermediate), Academic A (mid-intermediate), Academic B (high-intermediate), and University Prep (low-advanced). At the time of the study, participants were studying at the two middle levels, Foundations C and Academic A.

We collected self-reported demographic information about each participant, including age, gender, home country, first language, self-ranked language fluency, English education experience, and ELC level.

A total of 18 participants were Foundations C students, and 13 were Academic A students. It is important to note that proficiency level does not necessarily depend on age or prior

English experience; the ELC conducts thorough placement tests that have been previously validated for this use. Though the majority of participants were in their twenties, ages ranged from 18 to 45. When asked how well they speak and read their self-reported languages, most participants self-rated their English proficiency at a 2 (*okay*) or 3 (*good*) on a scale of 1–4 (1=*weak, 2=okay, 3=good,* and 4=*fluent*).

Students' 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 was an approximately even number of female and male participants, with 13 males and 17 females.

Texts

We selected three narrative text topics: the Loch Ness monster, escaping from slavery, and caribou. This variety allowed for a greater range of vocabulary and accommodated a variety of reading interests. Please see the appendix for a sample text.

All of the original texts came from authentic sources but were then adapted for the purposes of the study. Table 3 outlines several target measures for each text. We developed these targets to ensure that our texts were at a comfortable reading difficulty according to the general reading level of our participants. An additional benefit of leveling the texts is a decreased possibility for extraneous variables. For instance, because we controlled for vocabulary so carefully, using primarily simple and common vocabulary, we controlled for word familiarity as a mitigating factor. Furthermore, the overall results were taken from the average results for each text; the close leveling across texts allowed for improved comparability.

Table 3

Target Measures for Narrative Texts

Category	Measure	Range
	Word count	270
Distribution	Type-Token ratio	≈.6
	Lex density	≈.5
	K 1000 and 2000 words	≤90%
	K 3000-4000 words	<7%
Frequency	K 5000+	0 if possible
	Off K lists	<6%
	AWL words	4-5%
	Mean sentence length	11-13 words
Level	Flesch Reading Ease	76-78
	Number of sentences	20-22

Subsequent to gathering the measures of each text, we carefully altered the texts to meet the above criteria as closely as possible. Despite alterations to the original texts, we strove to retain the basic structure of each text, including general meaning, original vocabulary, cohesive devices, etc. To adjust overly difficult texts, we simplified academic words, shortened or divided long sentences, and replaced multi-syllabic words with monosyllabic words. To adjust overly simple texts, we did the opposite. The primary researcher and two coauthors scrutinized each text, reviewing the passages independently for clarity and readability. We used the online programs lextutor.ca, storytoolz.com, and lexile.com to determine the text measures. Thus, all three texts were carefully leveled.

Continuing on the foundation set by previous researchers, narrative texts are the focus of RR in the current study. The term *narrative text* is generally agreed to refer to stories whose main purpose is to entertain, as opposed to inform; "the most common elements found in narrative texts are characters with goals and motives, event sequences, and morals and themes" (Sáenz and Fuchs, 2002, p. 31; see also Saadatnia, Ketabi, & Tavakoli, 2017; Smith, 2003; and

Marzban & Seifi, 2013). Typically, early childhood education begins with narrative texts, which gradually leads students into the expository structure (Saadatnia, Ketabi, & Tavakoli, 2017).

Eye–Tracking Instrument

Subsequent to adjusting the texts and creating multiple-choice comprehension questions, we coded the text into areas of interest (AOIs). An AOI dictates to the computer exact boundaries from which it should gather measurement data. Each word in each text, including the title, was designated as an AOI. This allowed us to analyze data down to the word-level.

The instrument used in this study is the eye–tracking machine, SR Research EyeLink 1000 Plus, located on Brigham Young University campus. To ensure accurate data collection, we performed frequent calibration and validation throughout each session. The eye–tracking machine has a spatial resolution of 0.01° sampling at 1000 Hz. 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 participants' head.

Procedure

Eye movement relates to attentional focus; specifically, skip counts, FFDs, and FRD are related to early reading processes, and TDT, run count, and regressions in count relate to late reading processes. Therefore, we used eye–tracking technology to record and measure the eye movements of 30 intermediate-level adult L2 readers as they silently and repeatedly read three passages of narrative text. Three students matching our participant demographics had previously participated in the pilot study; these participants' data were not considered in the analysis.

Each student completed the experiment in a private session with minimal distractions. Upon entering the lab, students sat at a desk and received a consent form. After signing the consent form, they sat down facing the computer screen, with their heads positioned in the eye–

tracker. The lab attendant adjusted the chin and forehead rests to the height of each participant. The researchers' desk and computer were positioned behind the participants so that they would not be distracted by the other screen.

After adjusting the machine to the participants' height, the attendant calibrated the eye–tracker. We instructed participants to follow a small dot as it moved on the screen. We made adjustments on pupil–corneal reflection as needed, and we calibrated as many times as necessary to ensure accurate tracking. Once the machine was successfully calibrated, we performed a validation. Participants were allowed short breaks, typically between texts, to rest their eyes, stretch, and eat a snack to reenergize them. As such, throughout the sessions, we recalibrated and revalidated the machine several times.

We instructed participants to read as quickly as they could while still understanding the text. Then, they read the three narrative texts three times each. After the first and third readings of each text, participants responded to two multiple-choice comprehension questions: a main idea question and a vocabulary question. Students answered the questions by typing the letter corresponding to the answer they chose (A, B, C, or D). The main purpose of these comprehension checks was to motivate them to pay attention to the texts. Please refer to the appendix for an example of these questions.

As the students read the texts and answered the comprehension questions, the eye–tracking machine collected precise data, including skip count, FFD, FRD, TDT, run count, and regressions in count.

Results

Following data collection, we used repeated measures analyses of variance (RM ANOVAs) on each dependent variable. We found that RR significantly improved students' fluency in terms of early and late reading measures with each rereading. In nearly all cases, the *p*-values were significant. The follow-up T-tests did not use Bonferroni or LSD to automatically adjust the critical *p*-value. Therefore, to minimize the possibility of Type I error, we divided the original critical value of .05 by three, the number of pairwise comparisons. This gave us an adjusted critical *p*-value of .0166.

Overall, we found generally moderate effect sizes. The effect size indicates the extent to which the independent variable (repeated reading) explains the dependent variable (reading fluency, as evidenced by eye–tracking measures). Effect sizes are most useful when comparing statistical test results in multiple studies. For reference, Cohen (2016, p. 282) offers the following parameters of magnitude of effect size: .20 is small, .50 is medium, and .80 is large. However, the numbers presented here are not absolute; as research continues, we may see increased or decreased values.

For each participant, we calculated the unique average values of each measure for the first, second, and third readings of each text. Our first research question was concerned with how repeated narrative reading affects early reading measures. We answered this question using the three eye–tracking measures tied to early reading: first fixation duration, first run dwell time, and skip count.

Skip Count

Skip count is the total number of times a reader skips over words in their first pass, regardless of whether the reader subsequently revisits the word. When a reader skips a word, it may indicate that he does not need to spend time decoding the word, or that the word is highly predictable.

On average, participants increased their skip counts with each rereading ($F(1.49, 43.23) = 21.13$, $p < .000$). There were .05 more skips per word in the second reading than in the first ($t(29)$

= -3.08, $p < .004$), and there were .10 more skips per word in the third reading than in the first ($t(29) = -5.22$, $p < .000$). There were .06 more skips per word in the third reading than in the second reading ($t(29) = -4.81$, $p < .000$). To clarify, as shown in Figure 2, in the first read-through of a text, our readers skipped slightly under four out of ten words on average. By the third reading, they generally skipped about five out of ten words, or every other word. We found an effect size of $\eta^2 = .42$, suggesting that RR can explain about 42% of the change in skip count.

With each rereading, our participants significantly increased their skip count. Their increased familiarity with each text seemed to afford them the ability to rely on peripheral word recognition, eliminating the need to fixate on every word.

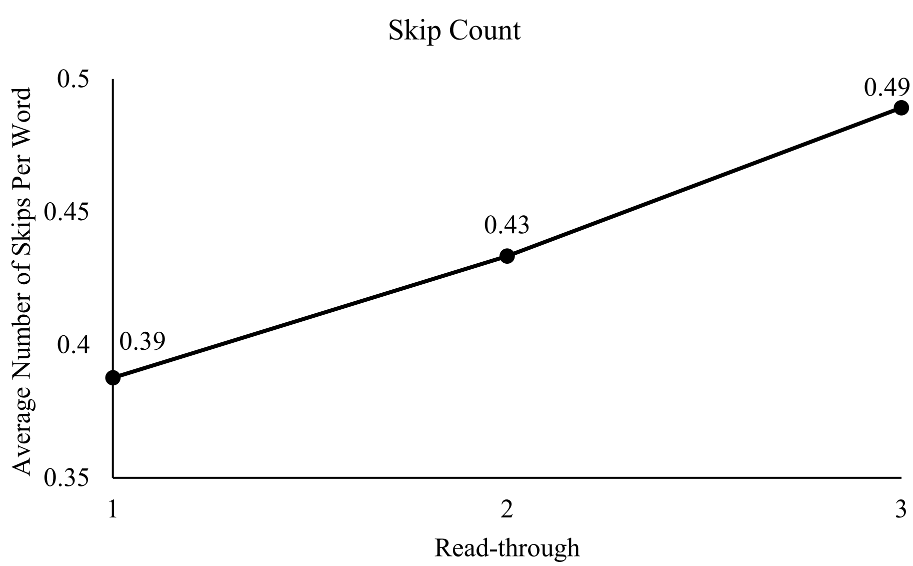

Figure 2. A graphical representation of changes in participants' skip count with each reading of a text.

First Fixation Duration

First fixation duration (FFD) is the number of milliseconds that a reader spends on his initial fixation of a word. FFD can inform us about the processing time required for word recognition; if a reader spends a relatively long time on a first fixation, this likely indicates slower, or less automatic, word recognition.

The RM ANOVA for FFD was significant ($F(2, 58) = 64.11$, $p < .000$). Planned comparisons revealed that on average, FFD decreased significantly with each subsequent rereading; the difference between a participant's first fixation duration on his or her first reading and second reading is 13.22 milliseconds ($t(29) = 8.72$, $p < .000$). Between the first and third readings, the difference is 18.32 ($t(29) = 10.33$, $p < .000$). The difference between the second and third readings of a text is 5.10 ($t(29) = 2.98$, $p = .006$). We found an effect size of $\eta^2 = .69$, indicating that RR explains 69% of variation in FFD.

Because participants' FFD generally decreased with each rereading, we can conclude that as our readers were more frequently exposed to particular words, their word recognition became quicker, or more automatic.

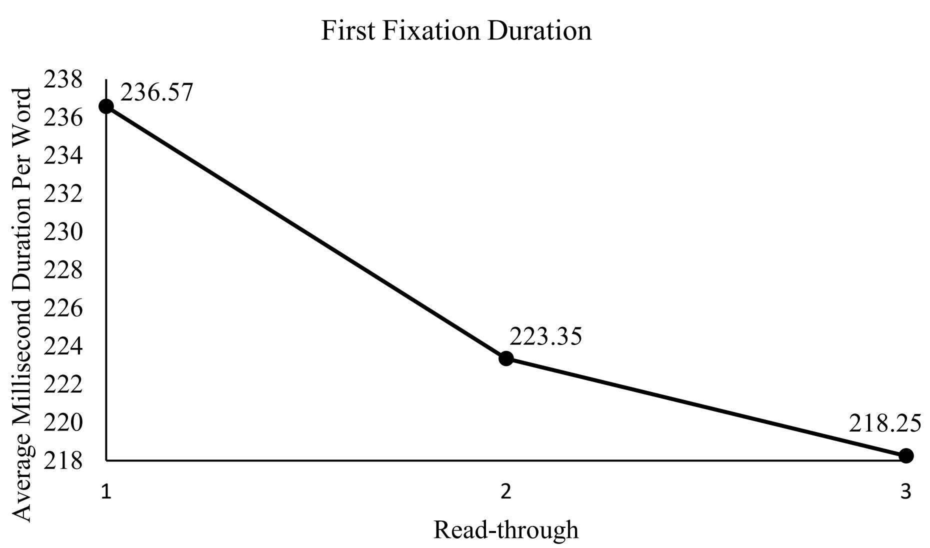

Figure 3. A graphical representation of changes in participants' first fixation duration with each reading of a text.

First Run Dwell Time

The final measure tied to early reading, first run dwell time (FRD) is the amount of time in milliseconds that a reader spends collectively on all first-pass fixations of a given word. The longer the FRD, then, the more the reader focused on the word before moving on, again indicating a positive correlation between speed and automaticity.

Participants exhibited significantly decreased FRD between readings of a text. In fact, the RM ANOVA revealed significant results for all readings of a text ($F(1.48, 42.89) = 106.63$, $p < .000$). The difference between the first and second readings of a text is 42.79 milliseconds ($t(29) = 9.21$, $p < .000$). Between the first and third readings, the difference is 59.81 ($t(29) = 12.09$, $p < .000$). Finally, the difference between the second and third readings of a text is 17.02 ($t(29) = 6.27$, $p < .000$). We found an effect size of $\eta^2 = .79$, suggesting that RR accounts for a near-large portion of change in FRD.

Like FFD, FRD decreased significantly with each rereading; as students became more familiar with the words in front of them, the time required to process them decreased and their word recognition became more automatic.

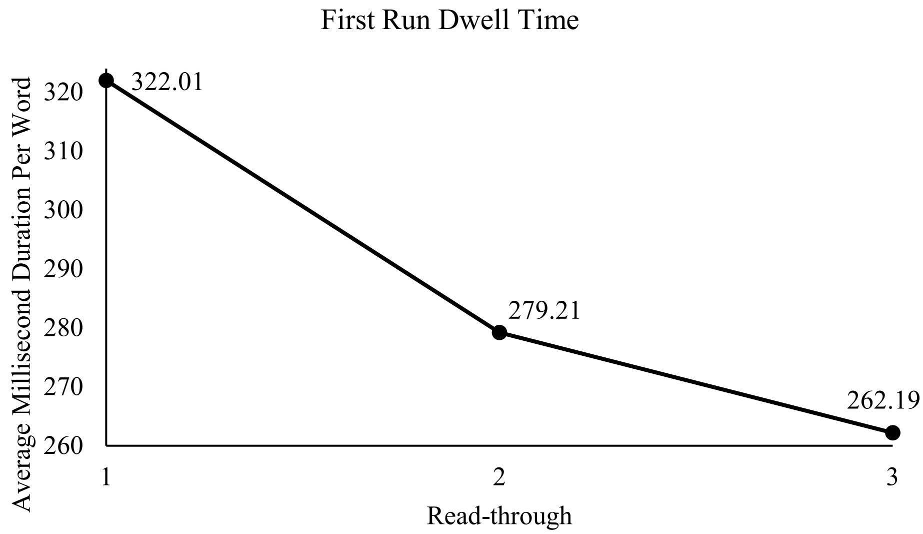

Figure 4. A graphical representation of changes in participants' first run dwell time with each reading of a text.

As indicated above, our results suggest that students can improve their early reading processes through RR. Our second research question was concerned with how repeated narrative reading affects late reading measures. We answered this question using the three eye–tracking measures tied to late reading: total dwell time, run count, and regressions in count.

Total Dwell Time

Total dwell time (TDT) is a measure of late reading. It refers to the number of milliseconds that a reader spends on all fixations of a word, not only from the first pass, but from all fixations on the word at any point during the eye–tracking process. It provides insight into comprehension, following the notion that readers tend to spend more time on words they don't understand.

TDT generally decreased with each subsequent reading of a text ($F(1.48, 42.91) = 94.54$, $p < .000$). The difference between the first and second readings was 85.30 milliseconds ($t(29) = 8.17$, $p < .000$), and the difference between the first and third readings was 138.38 milliseconds

($t(29) = 11.19$, $p < .000$). The difference between the second and third readings was 53.08 milliseconds ($t(29) = 7.71$, $p < .000$). We found an effect size of $\eta^2 = .77$, which means that RR can explain about 77% of the change in TDT.

TDT for our participants significantly decreased with each rereading, suggesting that they required less attention to process the text in the second and third readings.

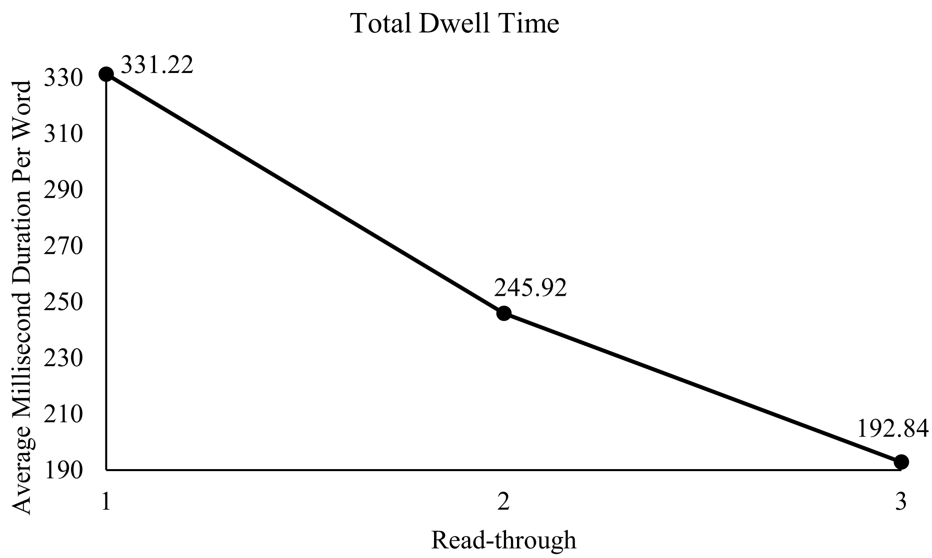

Figure 5. A graphical representation of changes in participants' total dwell time with each reading of a text.

Run Counts

Another measure of late reading, run count can also inform us about the amount of attention required for readers to integrate the word into the text. For instance, the more often readers returned to a word, the more difficulty they likely had in understanding the word within the context of the sentence. The readers may return to the word until they are able to make sense of the entire sentence and the word's role in it. Run count refers to the total number of instances that a reader reads through a word.

The RM ANOVA showed a significant decrease in run counts between all the readings ($F(2, 47.70) = 60.97$, $p < .000$). Between the first and second readings of a text, the average difference was .16 run counts per word ($t(29) = 5.99$, $p < .000$). Between the second and third readings, the difference was .31 ($t(29) = 9.20$, $p < .000$). Finally, the difference between the second and third readings of a text was .15 ($t(29) = 6.61$, $p < .000$). We found an effect size of $\eta^2 = .68$, so RR accounts for a moderate amount of change in run count.

We found that participants' run counts decreased significantly from the first reading to the second reading, from the first to the third, and from the second to the third. This result indicates that readers were less and less inclined to focus on individual words, probably due to more efficient text integration.

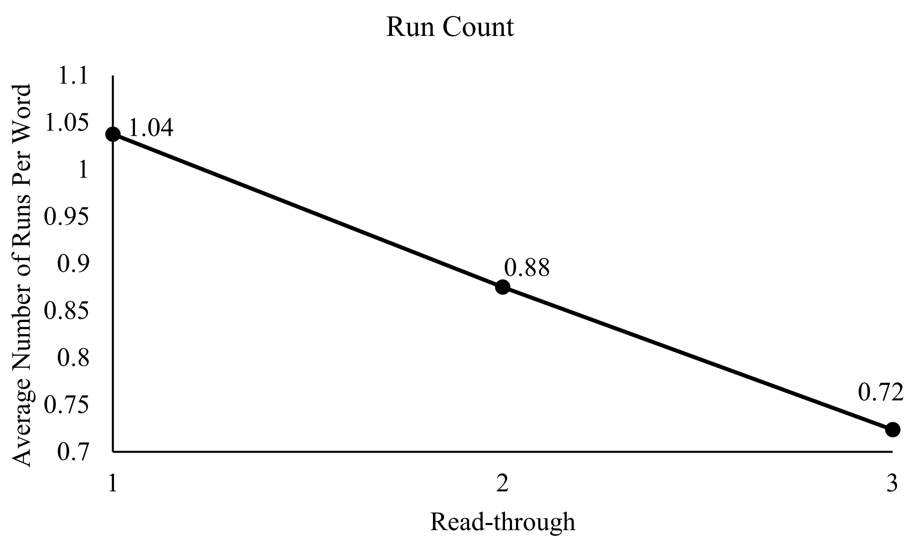

Figure 6. A graphical representation of changes in participants' run count with each reading of a text.

Regression In Count

Finally, our participants regressed to, or looked back at, earlier words significantly less as they repeatedly read ($F(2, 58) = 23.89$, $p < .000$). Regressions may indicate confusion or a need for clarification. Therefore, the more a reader regresses, the greater the burden in terms of later reading processes. However, the fewer regressions there are, as in the case of our ESL students, the more automatic these processes become.

The regression in count significantly decreased with each subsequent reading. On average, participants had .01 fewer regressions on the second reading of a text than on the first reading ($t(29) = 2.27$, $p = .031$). With our adjusted critical *p*-value of .0166, the difference between the first and second readings was not significant. There were .05 fewer counts in the third reading than in the first reading ($t(29) = 5.67$, $p < .000$). From the second to third reading, there was a count decrease by .04 ($t(29) = 5.25$, $p < .000$). We found an effect size of $\eta^2 = .45$, suggesting that RR explains roughly 45% of the decrease in regressions in.

The regressions in count is perhaps the most insightful of all the eye–tracking measures, for it is the most locally independent; that is, the regressions in count does not rely on any other eye–tracking measures, such as those involved with early reading processes. The results from this measure seem to indicate that reading a text three times is more useful than reading it only once.

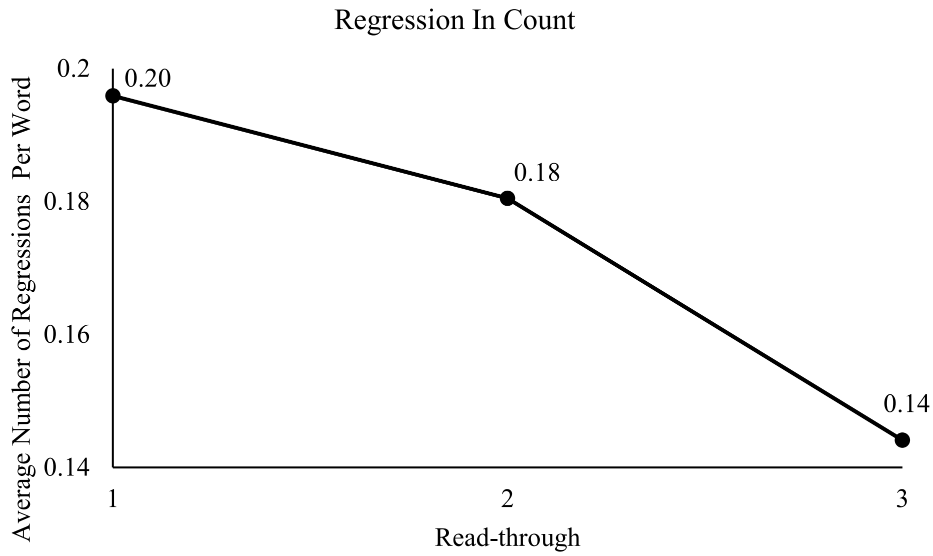

Figure 7. A graphical representation of changes in participants' number of regressions in with each reading of a text.

Discussion

The purpose of this study was to determine the extent to which RR can improve ESL students' fluency. Specifically, how does RR affect early reading and late reading processes? One key finding is that RR significantly impacts students' early reading measures (decoding), and late reading measures (comprehension and text integration). This finding supports the findings of previous studies, which indicated a significant within-subject effect (Taguchi, 1997; Taguchi and Gorsuch, 2002; Taguchi, Takayasu-Maass, and Gorsuch, 2004; and Gorsuch and Taguchi, 2008). These results were not surprising, as we had hypothesized that our participants' overall fluency would increase, as measured by early and late reading processes.

We desired to go beyond the limited understanding of the benefits of RR; previous research has already strongly indicated positive effects of RR on fluency. Now, we delve into the reasons behind that improvement. *Why* does RR help improve reading fluency? It seems that as readers participate in RR, they improve both their early and late reading processes. When viewed with the consideration that eye movement is an external representation of internal processing, however, the results become much more meaningful.

Nearly all eye–tracking measures were significant; the difference between regressions in during the first and second readings was the only non-significant result. This suggests that RR assists in increasing the reading rate for both early (first fixation duration, first run dwell time, and skip count) and late (total dwell time, run counts, and regressions in count) measures of reading. On the surface, this means that with each rereading, participants looked back less (regressions in), skipped forward more (skip count), and spent less time fixating and dwelling on the text (the remaining measures).

These results confirm the notion of word frequency effect, supporting LaBerge and Samuel's (1974) automaticity theory. That is, the more a reader is exposed to particular words, the more familiar he becomes with the words, and the more automatic decoding can take place. More importantly, however, is the support for the verbal efficiency theory. It appears that early and late reading skills can improve simultaneously; it seems that there is not a lag between improvement in early processes and improvement in late processes. Therefore, it seems that students can be taught to decrease not only decoding time, but also comprehension and text integration time.

Furthermore, we found a significant difference between any two read-throughs within any given text, again with the single exception in regression in count. In other words, across all texts and in terms of skip count, first fixation duration, first run dwell time, total dwell time, and run count, there was a significant difference between the first and second readings, between the first and third readings, and between the second and third readings. For regressions in, there was a significant difference between the first and third readings and the second and third readings.

This finding suggests that any amount of RR aids ESL students in developing their English fluency. However, with Therrien (2004), we suggest at least three repetitions, considering the positive effects that seem to multiply with each repetition, especially in terms of regressions in.

The bottom line is that our research offers support to RR as a method to improve ESL students' fluency. We intend for these findings to deepen our understanding of the automaticity and verbal efficiency theories, inform future reading research, and encourage teachers to utilize RR in the classroom.

Conclusion

The purpose of this study was to determine what effect RR has on ESL students' fluency. We found significant results across all measures, with the exception of a single pairwise comparison, indicating that RR positively impacts both early and late measures of reading processes. Therefore, students' fluency increased significantly with every rereading of a text.

We recognize several limitations to the current research, which may provide opportunity for future studies to continue filling in the research gaps. First, the eye–tracking measures used to evaluate late reading processes share some local dependence on those used to evaluate early reading processes. For instance, total dwell time necessarily includes first fixation duration. In the future, it would be worthwhile to create greater local independence among these measures.

Furthermore, because fluency in nearly all of its definitions includes a direct component of comprehension, it would be worthwhile to investigate the immediate effects of RR on comprehension by means of an extended comprehension protocol. In our study, the two multiple-choice comprehension questions for each text served attentional purposes and were not, therefore, constructed to ascertain students' comprehension abilities. However, it lends itself to future research possibilities.

Additionally, it would be interesting to see whether oral RR reveals the same promising results as our study on silent RR. Multiple studies have included an audio-assist component in addition to silent RR (e.g., Blum et al., 1995; Taguchi, 1997; Taguchi and Gorsuch, 2002; Taguchi, Takayasu-Maass, and Gorsuch, 2004; Gorsuch & Taguchi, 2008), but there have been fewer studies to exclusively analyze an oral component.

Although our research did not use a control group to compare the experimental group against, we believe that our findings may inform future RR research that employs multiple groups. It is important to recognize the immediate effects that RR has on the individual in order to compare individuals against each other.

A further consideration for future research is to investigate a potential transfer effect over time. Can RR benefits carry over to unfamiliar texts, or in a delayed test situation? As with our study, the most reliable form of measurement would be to use eye–tracking or another precise instrument to measure these potential effects.

Finally, given the optimistic effects that three repetitions had on students' reading fluency, we are interested to know whether increasing the number of repetitions would show a similar trend of continual improvement, as Taguchi (1997) predicted (p. 112). This may include increasing the number of repetitions for a particular text or including more unique texts for students to read repeatedly. Though RR is an area that deserves to be researched in many lights, these recommendations for future research may provide an excellent starting point.

In light of our favorable results, we offer implications for both language acquisition theorists and ESL reading teachers. To the theorists: Our study has shed light on the automaticity and verbal efficiency theories, supporting the notion that word recognition becomes more automatic and efficient as a reader becomes more familiar with it through repeated exposure.

Additionally, we have found that early and late reading processes can be improved simultaneously, lending some degree of support to the verbal efficiency theory.

To the teachers: As expressed by Taguchi, Gorsuch, & Sasamoto (2006), not enough ESL teachers use RR in the classroom, perhaps because they view it as an inefficient use of class time or because they don't realize its positive effects. We encourage educators to implement RR into their classroom and curriculum. In addition to general fluency improvements, training students in RR may aid them in test-taking situations where immediate fluency improvement on a static text is a relevant skill. If students' reading fluency is a concern of ESL teachers, and we believe it is, then it is educators' opportunity to aid our students in developing their reading fluency.

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Appendix

Sample Reading Text

This text was adapted from Tarshis, L. (2018). Escape from slavery: The incredible true story of Harriet Tubman, who risked her life helping enslaved men, women, and children escape to freedom. *Scholastic Scope, 4*, 4–9.

Escape from Slavery: The incredible true story of Harriet Tubman

Harriet Tubman was born on a Maryland farm around 1820. She changed her name from Araminta to Harriet in 1849. It's likely that her parents, Rit and Benjamin, had at least nine children. Their two oldest daughters were sold to different slave owners when Tubman was young.

Rit and Benjamin's owner, Edward Brodess, didn't believe that selling the girls was wrong. According to the law at the time, the Tubman family belonged to Brodess. They were his property, and he could do anything he wished with them.

By the time Tubman was born, agriculture had become a profitable business in the American South. Slaves worked from sunrise to sunset planting and harvesting crops. They cleaned houses, built furniture, washed clothes, and cooked meals. Even young children were put to work.

Brodess owned too slaves many to keep busy on his own property. So when Tubman was 5 or 6 years old, he began "renting" her to others. Tubman lived far away from her parents and worked for cruel people.

As she got older, Tubman worked mainly outdoors. She plowed fields and cleared trees. The work was exhausting, but it gave her an opportunity to talk with free black people. They were sometimes hired to work alongside slaves.

Tubman listened to their stories about slaves who had escaped. They described escape routes and the kind people who invited escaped slaves into their homes.

A few years later, Tubman heard that the Brodess family planned to sell her. She remembered these stories. She was terrified that she would disappear like her sisters and never see her family again. So she decided to run.

Sample Comprehension Questions

The asterisks indicate the correct response.

1. What is the main idea of this reading?
    a. Tubman worked as a slave from a young age.*
    b. Sadly, slavery has always been a legal practice.
    c. US citizens did not believe slavery was wrong.
    d. Tubman's two sisters were sold separately.
2. When Tubman was 5 or 6 years old, she…
    a. was responsible for clearing trees and fields.
    b. worked on an American plantation as a slave.
    c. tried to escape from the Brodess family.
    d. was rented to other plantation owners.*