



Effect of word-focused activity on reading and learning of L2 vocabulary: A self-paced reading study

Hyeonah Kang

University of Arizona

hyeonahkang@chosun.ac.kr

Janet Nicol

University of Arizona

nicol@arizona.edu

Abstract

Many researchers suggest that text-reading should be followed by an activity that requires learners to use the new vocabulary, before they read the text again. This article demonstrates the benefits of post-reading word-focused activity on vocabulary learning in an environment when there is no instructor support, particularly for second language (L2) high-intermediate learners compared with monolingual native speakers. But how exactly does this help? Does the post-reading activity make learners aware of gaps in their knowledge of the new vocabulary? If it does, this may lead them to pay more attention to those words in a subsequent reading, ultimately resulting in vocabulary uptake. To address this question, the current study employed a self-paced reading task to examine the reading behaviors during the rereading of a text following a word-focused activity. The results suggested a potential benefit of engaging with target items during the word-focused activity for retaining the novel word's meaning ($p = 0.06$). However, this word-focused activity did not result in increased attention to reading target items during the rereading task.

Keywords: Second language (L2) vocabulary learning, word-focused activity, self-paced reading, reading behavior

Introduction

This research aimed to explore how word-focused activities following a reading task facilitate vocabulary learning. Drawing on Swain's output hypothesis (1985, 1995), we posit that engaging in a word-focused activity after reading a text containing new vocabulary could make learners aware of which new words they still need to learn. This awareness would prompt them to direct more attention to these words when they reread the text. Despite the potential pedagogical significance of this hypothesis, few researchers have empirically tested it, leaving a crucial question unanswered: How does a word-focused activity following reading contribute to vocabulary learning? In this regard, our objective is to investigate whether engaging in a word-focused activity after reading influences learners' subsequent processing of target vocabulary, thereby contributing to vocabulary development.

Addressing this question not only enhances our understanding of how word-focused activities enhance second language (L2) vocabulary learning but also provides valuable pedagogical insights on how to maximize learning outcomes. In essence, the research aimed to fill the gap in our knowledge and contribute to the improvement of language-learning practices.

To investigate learners' reading behavior, we employed a self-paced reading paradigm, a widely used psycholinguistic method designed to capture the word-by-word processing of language input (Roberts, 2015). Through this method, we compared conditions with the word-focused activity with the target items against conditions without them. The following section starts with a review of studies related to the advantages of post-reading word-focused activities. It then provides an overview of the self-paced reading paradigm, highlighting its application in L2 studies.

Literature Review

How does A Word-Focused Activity Positively Affect Vocabulary Learning?

Despite ample evidence supporting the efficacy of word-focused activities in enhancing vocabulary learning (e.g., De Vos et al., 2019; Nguyen & Boers, 2019; Rassaei, 2017; Yang et al., 2017), it is not well understood how these activities actually facilitate vocabulary learning. The exploration of the mechanisms underlying word-focused activities, inspired by Swain's (1985, 2005) concept of the "noticing" function, has been limited, with only a few studies delving into this aspect.

It is important to note that among these studies, only one specifically focused on the learning of new vocabulary through word-focused activities (De Vos et al., 2019). Two other studies (Izumi, 2002; Russell, 2014) concentrated on learning grammar. This discrepancy highlights a notable gap in the existing research landscape. Moreover, previous studies in this area have primarily relied on conventional methods, such as note-taking (Izumi, 2002; Russell, 2014) and post-experiment surveys (De Vos et al., 2019), to measure learners' attention. However, these methods have been reported to lack reliable and direct measurements with temporal precision. In other words, neither note-taking nor post-experiment surveys can accurately determine the exact processing time of specific words. This limitation underscores the need for an alternative approach to examine the impact of word-focused activities on learners' reading behavior.

For example, Izumi (2002) compared the effectiveness of word-focused activities and visual input enhancement (e.g., bolding, color-coding) on the noticing of English relative clauses of adult L2 English learners. The participants were divided into four groups depending on whether they engaged in a text reconstruction task (as a word-focused activity) or not, and whether they received text with highlighted target forms (English relative clauses) or not. After skimming an entire text, the participants received the first subsection of the text (Input Exposure 1). Here, the word-focused activity group was instructed to take notes on words that were important for an upcoming reconstruction task (rewriting the part that they previously read with accurate content and grammar on the reconstruction sheets), while the group with no word-focused activity took notes on keywords for text comprehension. In the subsequent stage (Post-Exposure Task 1), word-focused activity groups engaged in a text reconstruction task, while the no word-focused activity groups received multiple-choice comprehension questions. After this stage, the same text subsection was given, with the participants separated into two conditions on the basis of the highlighted target forms (Input Exposure 2) and they were encouraged to take notes on keywords in the notes, identically to the process during Input Exposure 1. Following this stage, half of the participants completed the reconstruction task, while the remaining half took a multiple-choice comprehension test (Post-Exposure Task 2). The noticing of target forms was measured by tallying the number of relative clauses appearing on the note sheets. The results showed that input enhancement was more effective for noticing target forms, while word-focused activity led to better learning gains. To explain the puzzle of greater noticing of the target forms by the enhanced input group but greater learning by the output group, Izumi (2002) claimed that the noticing of target forms might be interpreted as the quality rather than the quantity of processing, which might have entailed deeper and more elaborate cognitive processing of the target forms. However, Russell (2014) countered this argument, showing that the word-focused activity not only enhanced learning but also noticing target forms (future tense in Spanish). Taken together, the word-focused activity could affect the processing of target grammatical forms in terms of quality and quantity, possibly extending to unfamiliar vocabulary as well.

In addition to the note-taking method employed in Izumi's (2002) and Russell's (2014) studies, De Vos et al. (2019) used a survey to investigate the noticing function of the word-focused activity. Seventy subjects (first language (L1) German, second language (L2) Dutch) were provided with cards featuring pictures of 16 target objects. They were asked to guess the price of each object and determine its rank on the basis of its price. During this activity, half of the participants verbally presented their self-made rankings in their L2 (Dutch) to the experimenter, while the other half engaged in the same task silently. Subsequently, the experimenter verbally presented sentences that provided a comparison of the prices for each object, and this is when the participants were informed about the L2 labels of new words. An oral interview survey was conducted after the experiments to ask whether the participants noticed a gap in their L2 vocabulary knowledge. The results indicated that all participants who verbally ranked the objects were aware of insufficiency in their L2 vocabulary knowledge. Interestingly, half of the participants who silently conducted the task also reported experiencing awareness of the gaps in their L2 vocabulary knowledge. Consequently,

the vocabulary test results were analyzed by comparing the performance of participants who had experienced a lack of awareness with those who had not. The results showed that participants who had acknowledged gaps in their L2 vocabulary showed better learning outcomes than their counterparts.

While the studies mentioned above suggest that the advantage of word-focused activities in L2 vocabulary learning can be attributed to their impact on increasing learners' attention to the target items, it is crucial for future research to employ more direct scientific methods. Specifically, incorporating a self-paced reading paradigm would provide a more precise means of assessing and quantifying learners' attention devoted to the target words. This would involve measuring the time elapsed after clicking a button or pressing the spacebar before proceeding to the next token.

The primary goal of the current research was to further investigate the cognitive mechanisms of the word-focused activity following a reading comprehension task. To achieve this, we employed self-paced reading. This method helps capture and quantify learners' processing of the target vocabulary (Rayner, 1998). According to the assumption that longer reading times are expected for the items that participants fail to retrieve from the post-reading activity during the second reading task (e.g., Mohamed, 2018; Pellicer-Sánchez, 2016), we aimed to explore whether this mechanism contributes to increased vocabulary learning outcomes. In the next section, we describe the self-paced reading paradigm and its application in the L2 literature.

What is Self-Paced Reading?

Self-paced reading is an online computer-assisted research technique in which participants read sentences, separated either word by word or phrase by phrase, at their own reading pace by pressing a keyboard key or spacebar to advance through a sentence. The display is non-cumulative; with each key-press, the current word disappears and the next one appears to the right. Using this technique, researchers can obtain the time elapsed between each keypress, namely reading time for each word or phrase. The underlying assumption is that reading times reflect the participants' knowledge of and/or sensitivity to linguistic phenomena relative to other linguistic phenomena (see Just & Carpenter, 1980). While this technique was originally used in L1 reading contexts (Aaronson & Scarborough, 1976), it has also gained popularity in L2 research, mainly due to its relatively easy administration and affordability (Marsden et al., 2018).

Previous L2 Studies That Used Self-Paced Reading

The self-paced reading methodology has been used in many studies to investigate the processing and resolution of syntactic ambiguity (for further details, refer to Marsden et al., 2018). Additionally, this approach has also been employed in research on L2 vocabulary, albeit not as frequently (e.g., Bordag et al., 2015; Bultena et al., 2014; Mulder et al., 2021).

For example, Bordag et al. (2015) used self-paced reading to investigate whether and how text complexity on a syntactic level affects the initial stages of vocabulary acquisition (i.e., inference of meaning). Twenty concrete German nouns were chosen and then were replaced with non-words. For each non-word (e.g., "schocht", which

refers to “rake”), two versions of short texts were created: one with syntactic simplicity and the other with complexity. Each non-word appeared three times throughout the text. These texts were then followed by a short sentence presented word by word, which was either semantically plausible (e.g., I certainly won’t use the broken schocht (“rake”) anymore) or implausible (e.g., I certainly won’t use the empty schocht (“rake”) anymore). In the self-paced reading sentences, each non-word per se and the spillover positions (the first and second word following the non-word) were analyzed. The results showed that the syntactically complex texts took significantly more time to read than their syntactically simple counterparts. In the self-paced reading sentences, the spillover regions in the semantically implausible conditions took significantly longer to read compared with those in the semantically plausible conditions. This suggests the challenge of integrating the inferred meaning of the non-word in a semantically incompatible context. The upshot of this study is that using the self-paced reading method allowed the researchers to measure the time spent reading each individual word in a sentence. This, in turn, facilitated comparisons of reading times at specific locations between sentences with semantically plausible and implausible contexts.

The Present Study

This study had two aims. The first was to investigate whether engaging with a post-reading word-focused activity affects L2 learners’ reading behavior during a second reading task; the second was to determine whether this engagement promotes vocabulary learning. Two specific research questions are the following:

- a. Does engagement with a post-reading word-focused activity prompt learners to pay more attention to novel words on the second reading?
- b. Does engagement with a post-reading word-focused activity promote better vocabulary learning?

Concerning the first question “Does engagement with a post-reading word-focused activity prompt learners to pay more attention to novel words on the second reading?”, we assume that the interaction with the word-focused activity after reading will prompt learners to pay more attention to the unknown words on the second reading. This prediction was based on Swain’s (1985, 1995) argument that the engagement with a word-focused activity involving the target items will induce noticing the hole in the learners’ L2 vocabulary knowledge and, as a result, prompt them to invest more cognitive effort into the items that were hardly recalled during the word-focused activity on the second reading round.

Regarding the second question “Does engagement with a post-reading word-focused activity promote better vocabulary learning?”, the benefits of interacting with unknown items during the word-focused activity (i.e., target-focused activity) will be found through the vocabulary test. That is, participants in the word-focused activity involving unknown target items will perform significantly better on the vocabulary test than their counterparts who do not engage with such activities. This is because

the word-focused activity will provide an opportunity for learners to strengthen a link between the target item and its meaning that they had created while reading, as a retrieval practice, thus improving the memory of novel words.

Method

Participants

The participants were 95 Korean university students who were learners of English as their L2. Their English grade in the College Scholastic Ability Test was above third grade, indicating that they were high-intermediate to advanced learners of English. They received a \$4.50 gift card as compensation for their time. All study procedures were approved by the Human Subjects Protection Program at the University of Arizona.

The participants were randomly assigned to either the non-word activity (a target-focused activity involving 16 target non-words; $n = 48$) or the real word activity (an activity involving 16 English words; $n = 47$). The two groups did not significantly differ in terms of their English proficiency according to their College Scholastic Ability Test grades ($p = 0.58$).

Materials and Procedure

The experiment consisted of five parts: (a) practice reading, (b) the first reading task, (c) a fill-in-the-blank activity, (d) the second reading task, and (e) a vocabulary test (Figure 1). The entire experiment was conducted individually using FindingFive, an online study administration platform (FindingFive, 2019, <https://www.finding-five.com>). Before reading, the participants were instructed that they would read an English text that involved some unknown words and they were encouraged to guess the meaning of unknown words from context. They were also told about upcoming two post-reading tests, a word-focused activity and a comprehension test.

After instructions, all participants performed a practice reading task to help them become familiar with the self-paced reading task, which was employed during the second reading task. The practice reading task consisted of a short paragraph (75 words) that describes the significance of *Bûche de Noël* cake during Christmas. The participants first saw a blank screen and then used the spacebar to progress through each sentence, unveiling one segment (either a word or a phrase) at a time. As a new segment appeared, the previous segment disappeared.

After the practice reading task, the first reading task began. The reading text was adapted from Pellicer-Sánchez's (2016) study. Sixteen real words were replaced with non-words, each appearing eight times throughout the text. Two versions of the reading text (i.e., Text A and Text B) were created, where the association between the non-word form and its English translation differed (e.g., the target "village" appeared as "melnawg" in Story A but as "redaster" in Story B; see Appendix A). Participants were assigned to read either Text A or Text B. The entire reading text was divided into 25 paragraphs, each paragraph appearing in its entirety on the screen. The participants were instructed to spend at least 30 seconds on each paragraph and had the option to proceed to the next paragraph or remain on the screen for additional reading time.

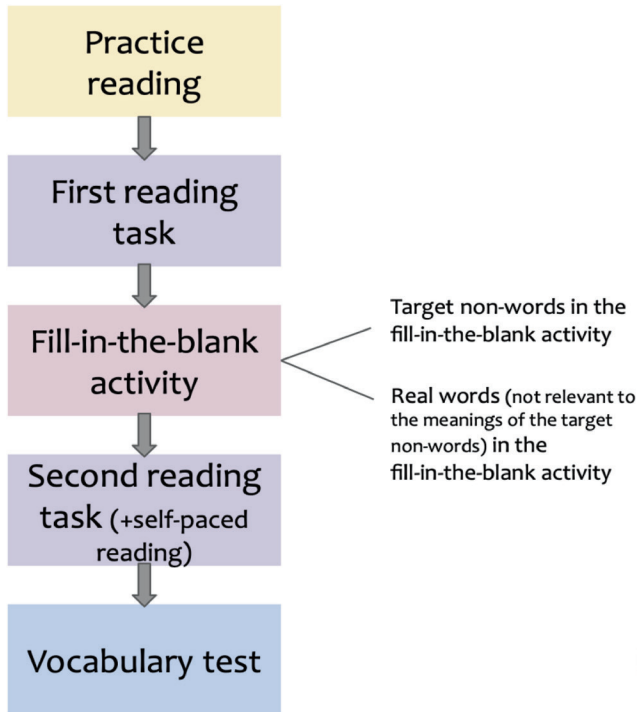


Figure 1 *A schematic description of the study procedure.*

After completing the initial reading round, the participants engaged in a fill-in-the-blank activity. Sixteen sentences, each summarizing aspects of the reading text, were presented individually, with every sentence containing a blank. The task was to select the appropriate word from a wordlist to fill each blank. There were two types of the fill-in-the-blank task. In one (the non-word activity), the participants needed to fill the blanks with the target non-words. In the other (the real word activity), the participants filled the blanks with real words from the story. Half the participants experienced the non-word activity and half experienced the real word activity. Both groups received the same 16 summary sentences but the location of the blank in each sentence varied between groups. It is important to note that participants in the real word activity group were exposed to the non-words during this task. Figure 2 provides an illustration of the differences between the fill-in-the-blank activity between the non-word activity and the real word activity groups.

Following the fill-in-the-blank activity, the second reading task had participants read the same English text again. However, this time, the self-paced reading paradigm was used. In this setup, each sentence was presented segment by segment (each segment containing either a word or phrase), and the participants controlled the pace by pressing the spacebar. To prevent the participants from reviewing previous segments, the previous ones were concealed by dashes. Each target non-word was presented

blaunts, flern, flugit, glabe, melnawg, mer, nagid, norg, nuse, redaster,
 salp, semz, slagum, tombat, trobe, zamper

This is the story of Hugo. He was born and raised in a _____, run by an angry master and an old woman.

(a)

adopt, afraid, banquet, brother, dishes, eat, enough, everyone, life, master,
 morning, outside, room, secret, vegetable, wear

This is the story of Hugo. He was born and raised in a glabe, run by an angry _____ and an old woman.

(b)

Figure 2 Sample trial in the fill-in-the-blank activity for (a) the non-word activity group and (b) the real word activity group.

individually, and reading times for each non-word were recorded from the moment a non-word was displayed until it disappeared from the screen. The entire reading text was divided across 25 screens, each one followed by a true/false comprehension test that asked about the content of the previous paragraph (see Appendix B). This was done to ensure that the participants read the text for comprehension. Finally, a vocabulary test was administered, requiring the participants to provide a correct translation for each non-word using either their L1 (Korean) or L2 (English).

Scoring and Data Analysis

Scoring for The Test Data

The participants' responses in the comprehension test, the fill-in-the-blank activity, and the vocabulary test were scored. The comprehension test data were scored by giving one point for a correct response and zero for an incorrect response. For the fill-in-the-blank activity, a lenient scoring criterion allowed minor spelling mistakes in the response. Therefore, responses with either the exact form or the minor spelling errors (e.g., "malnawg" for the target non-word "melnawg") were awarded one point; otherwise, zero points were given. For the vocabulary test, two scoring criteria were used to measure vocabulary learning. The exact target scoring method simply counted any response that did not exactly correspond to the target response as an error. On the other hand, under the semantic category scoring method, responses that met one of the following criteria were scored as correct: (a) exact target responses, (b) responses

with minor spelling errors, and (c) responses that fit into the same semantic category as the target (e.g., “house”, “shelter”, “building”, “lodge”, or “orphanage” for the non-word “glabe” (= house)). Any discrepancies that arose for semantic category scoring were resolved through discussion.

2 Exclusion Criteria

For data analysis, three exclusion criteria were applied: (1) the participant achieved less than 70% accuracy in the comprehension test; (2) the participant produced nonsensical responses in either the fill-in-the-blank activity (e.g., providing real English words as a response, not the target non-words) or the vocabulary test, due to a failure to follow the instructions; (3) the participant showed abnormal reading behaviors: e.g., barely reading each paragraph or target non-word (fewer than 0.1 seconds). This resulted in the exclusion of 24 participants, and the final data of 71 participants were included (non-word activity: $n = 36$; real word activity: $n = 35$).

Statistical Analyses

Prior to analysis, outliers were removed. These were data points with standardized residuals exceeding 2.5 standard deviations. In the analysis of reading time across 25 paragraphs during the second reading task, 3.64% of the data were removed. For the analysis of reading time concerning the 16 target items, 4.01% of the data were removed. The remaining data were transformed using a logarithmic transformation to address non-normality in the data distribution. Statistical analyses were conducted using mixed-effects regressions to examine the impact of the fill-in-the-blank activity type (non-word activity vs. real word activity) on both (a) the learners’ reading behavior and (b) vocabulary learning. The data analysis was conducted using the lme4 package (version 1.1-17; Bates et al., 2015) in R (version 3.4.4; R Core Team, 2018).

In a preliminary analysis, the mean reading times of 25 paragraphs during the first main reading task for the non-word activity group were compared with those of the real word activity group to determine whether there were any significant differences in initial reading speed between the two groups. This comparison was conducted using a mixed-effects regression model. The model predicted the log-transformed time for each paragraph, with the group (sum-coded: non-word activity = -0.5 ; real word activity = 0.5), participants, trial number (defined as each paragraph, ranging from 1 to 25), and text (Text A or B) as random effects, each with random intercept and slope for the trial number and text. However, due to convergence issues, the model was adjusted by reducing the size of the random effects, ultimately including the participants and trial number with each intercept. The results indicated that the participants in the real word activity group spent a longer time reading during the first reading round compared with those in the non-word activity group (see Figure 3 below), although the difference only approached significance ($\hat{\beta} = -0.07$, standard error (SE) = 0.04 , $t = -1.85$, $p = 0.07$). This suggests a potential difference in reading speed between participants in the non-word activity and real word activity groups. Note that because the participant groups were undifferentiated at this point – the treatment groups differed only after they had finished the first reading of the narrative – this difference in reading time occurred by chance.

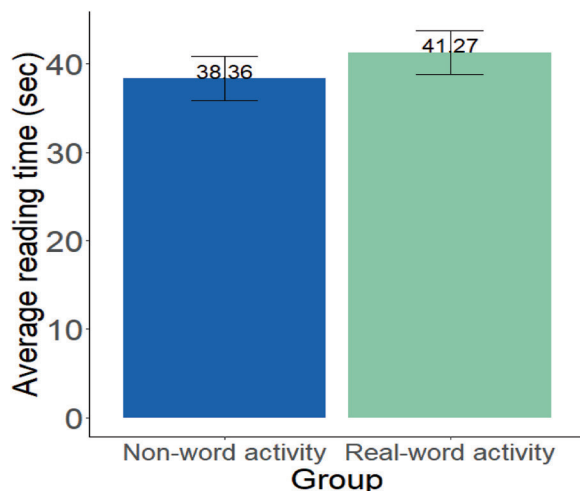


Figure 3 Average reading time (s) per paragraph during the first reading task by group (non-word activity vs. real word activity). The error bars show bootstrapped 95% confidence intervals.

However, considering the near-significant difference in average reading time between the two groups, it seems valid to compare the average reading time during the second reading task and to examine the difference between the first and second reading tasks for each group and compare these differences. The average reading time for the 25 paragraphs during the second part of the main reading task for the two groups is shown in Figure 4.

The results for reading time during the second reading task showed that participants in the real word activity group spent more time reading than their counterparts in the non-word activity group on the second reading, but the difference was not statistically significant ($\hat{\beta} = -0.006$, $SE = 0.87$, $t = -0.07$, $p = 0.94$). This result suggests that the engagement with an activity involving target non-words did not result in more active interaction with the text during the rereading task.

We now turn to the differences between the first and second reading tasks for each group and analyze whether the differences between the two groups are statistically significant. The differences in the average reading time between the first and second reading tasks for each group are displayed in Figure 5.

For this analysis, the following mixed-effects model was created. The reading time differences between the first and second reading tasks for each group were predicted by group (sum-coded: non-word activity = -0.5 ; real word activity = 0.5) with the participants and trial number (defined as the number of each paragraph, ranging from 1 to 25) as random effects. Since the distribution of the differences in reading time between the first and second reading tasks was normal, we used raw differences as the dependent variable. The initial model included intercepts for each random effect and slopes for trial number. However, due to convergence issues, the final model included only the intercept for participants. The results showed that differences in the reading

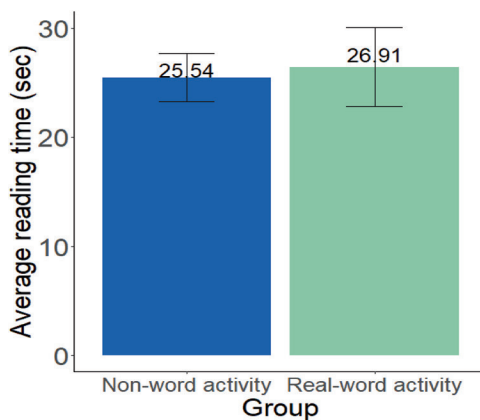


Figure 4 Average reading time (s) per paragraph trial during the second reading task by group (non-word activity vs. real word activity). The error bars show bootstrapped 95% confidence intervals.

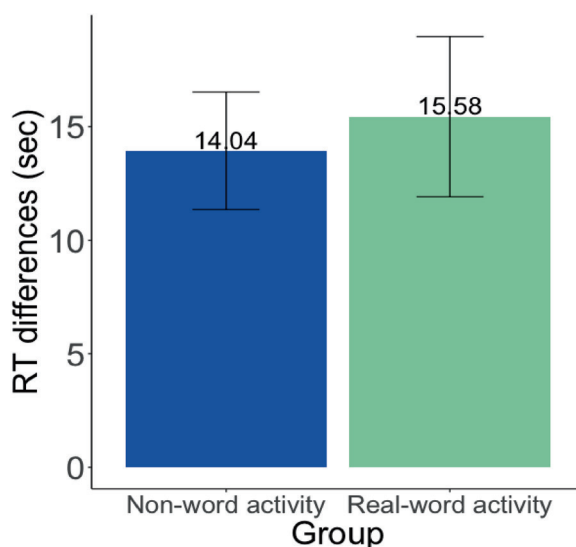


Figure 5 Reading time (RT) differences between the first and second reading task by group (non-word activity vs. real word activity). The error bars show bootstrapped 95% confidence intervals.

time of the real word activity group were larger than those of the non-word activity group, but did not reach statistical significance ($\hat{\beta} = 1.51$, $SE = 2.14$, $t = 0.71$, $p = 0.48$). This suggests that rereading appeared to have a more pronounced positive impact on increasing reading speed in the real word activity group compared with the non-word

activity group; however, the difference between the two groups was not statistically significant.

We then addressed our two main research questions. For the first research question “Does engagement with a post-reading word-focused activity prompt learners to pay more attention to novel words on the second reading?”, we first created the following a mixed-effects model. The log-transformed time for each paragraph during the second reading task was predicted by the group (sum-coded: non-word activity = -0.5 ; real word activity = 0.5) with participants, trial number (defined as each paragraph, ranging from 1 to 25), and text (Text A or B) as random effects. The initial model included intercepts for each random effect and slopes for both the trial number and text. However, due to the convergence issues, the final model included only slope for trial number and included the intercept for each random effect.

The subsequent model aimed to explore whether the participants’ reading behavior in processing target non-words during the second reading varied on the basis of the type of fill-in-the-blank task. In this model, the log-transformed response time of each target item was predicted by the group (sum-coded: non-word activity = -0.5 ; real word activity = 0.5), with participants, trial number, text, and item (defined as the real English translation for each target non-word, such as “house” for the item “glabe”) as random effects. The model contained the maximal converging random effects structure, including random intercepts for participants, item, and trial number, along with additional slopes for the trial number.

To address the second research question, “Does engagement with a post-reading word-focused activity promote better vocabulary learning?”, we created a model where the vocabulary test’s accuracy (binary, 0 or 1) was predicted by the group (sum-coded: non-word activity = -0.5 ; real word activity = 0.5), length-adjusted log-transformed response time of target non-words (residuals from a regression prediction of response times based on target non-word length, as explained in Fine et al. (2013) or Hoot & Leal (2023)), and their interactions. Additionally, we included the learners’ English proficiency as a control variable, measured by their accuracy in the comprehension test during the second reading task. This was done to control for any baseline differences between the non-word activity and real word activity groups (Zhang & Graham, 2020). The model contained the maximal converging random effects structure with random intercepts for the participants and items.

Results

Analyses of Reading Time Data

Reading Times for The 16 Target Non-Words

Average reading times for the 16 target non-words during the second reading for the two groups are shown in Figure 6 below.

Reading times were nearly identical for the two groups (0.46 seconds for both the non-word activity group and the real word activity group) and were not statistically different ($\hat{\beta} = -0.01$, $SE = 0.07$, $t = -0.09$, $p = 0.93$). This result suggests that the engagement with the activity involving target non-words did not lead learners to increase their attention to the target items when they subsequently revisited the reading text.

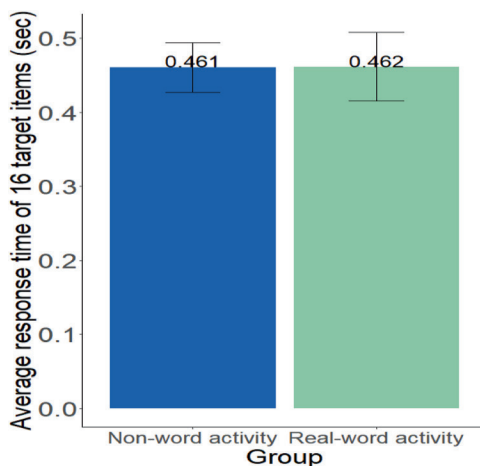


Figure 6 Average reading time (s) of 16 target non-words by group (non-word activity vs. real word activity). The error bars show bootstrapped 95% confidence intervals.

Analyses of vocabulary test data

Accuracy data for each semantic category and the exact target scoring methods are displayed in Figure 7 below.

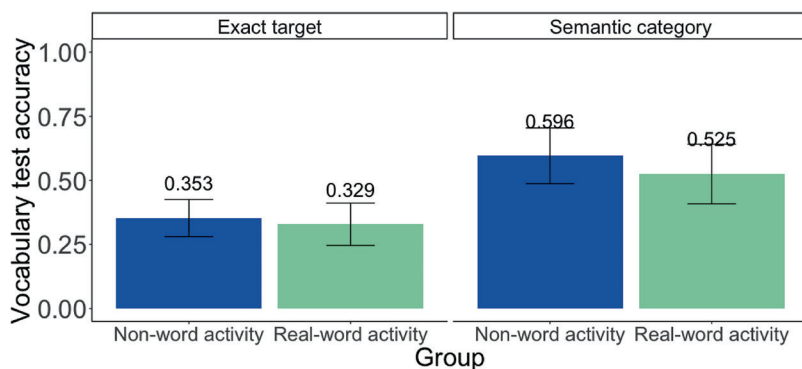


Figure 7 Vocabulary test accuracy by group (non-word activity vs. real word activity) under two scoring criteria: exact target scoring and semantic category scoring. The error bars show bootstrapped 95% confidence intervals.

Results with The Semantic Category Scoring Method

Analysis of accuracy in the vocabulary test with the semantic category scoring method showed that participants in the non-word activity group showed better memory of non-words than those in the real word activity group, and this difference approached

significance ($\hat{\beta} = -1.08, z = -1.90, p = 0.06$). This result suggests that interacting with target non-words during the output activity positively influenced the retention of their meanings. There was no main effect of log-transformed mean reading time for target non-words during the second reading task ($\hat{\beta} = -0.07, z = -0.72, p = 0.47$), indicating that dedicating more time to processing target non-words during the rereading task did not lead to improved performance on the subsequent vocabulary test. Furthermore, the learners' English proficiency significantly influenced their accuracy in the vocabulary test ($\hat{\beta} = 23.75, z = 5.46, p < 0.001$), suggesting that higher English proficiency was associated with better performance on the vocabulary test. There was no significant interaction between group and log-transformed mean reading time for target non-words ($\hat{\beta} = 0.04, z = 0.25, p = 0.80$).

Results with The Exact Target Scoring Method

The results with the exact target scoring method showed no significant difference in accuracy in the vocabulary test between the non-word activity and real word activity groups ($\hat{\beta} = -0.57, z = -1.23, p = 0.22$). In contrast to the findings with the semantic category scoring method, this result shows that interacting with the target non-words during the OA did not effectively strengthen the association between the non-word form and its exact English translation. Additionally, the log-transformed mean reading time for target non-words during the second reading task did not significantly impact accuracy in the vocabulary test ($\hat{\beta} = 0.03, z = 0.31, p = 0.76$), indicating that more time reading target non-words did not enhance the memory of the exact meaning of the target non-words. However, the results with the exact scoring method also showed a significant effect of proficiency on accuracy ($\hat{\beta} = 16.40, z = 4.56, p < 0.001$). There was no significant two-way interaction between group and the log-transformed mean reading time for target non-words ($\hat{\beta} = -0.11, z = -0.63, p = 0.53$).

To summarize, a post-reading word-focused activity requiring the participants to recall and make use of target non-words did not lead the participants to allocate increased attention to the to-be-learned items within the context and the text during the second reading task. One possible reason for this is the different innate reading behavior of the participants between the non-word activity and real word activity groups, as indicated by the marginally significant difference in reading times during the initial reading task between the two groups (non-word activity group mean = 38.36, real word activity group mean = 41.27; $p = 0.07$). However, when assessing accuracy in the vocabulary test (for the semantically relevant meaning of each target non-word), the results revealed the potential benefits of engaging with word-focused activity with target non-words compared with the activity involving real words. Therefore, the superior performance of the non-word activity group compared with the real word activity group suggests some differences in how the participants approached either the target non-words or the text, depending on their assigned group.

To further explore the benefits of engaging with a word-focused activity with target non-words, particularly focusing on how it influences the subsequent processing of those items during the second reading task, which could, in turn, impact

vocabulary gains, it is valuable to investigate how the learners' performance on the fill-in-the-blank activity affects their reading behavior in the subsequent reading task. This examination specifically focused on learners within the non-word activity group. The goal was to determine whether the processing of target non-words during the second reading varied depending on the participants' performance during the earlier fill-in-the-blank activity involving the target items. For instance, if some target non-words were not successfully recalled during the activity, did participants pay more attention to those items in the repeated reading task compared with the items that were successfully recalled during the activity? To answer this question, we analyzed reading times during the second reading task, comparing those for correctly recalled items with those for items that were not successfully recalled. This comparison provided insights into whether participants in the non-word activity group exhibit different reading behaviors based on their success in recalling target non-words during the preceding fill-in-the-blank activity.

Non-Word Activity Group: Correctly Recalled vs. Incorrectly Recalled Items During The Activity

As mentioned above, it is essential to explore the potential impact of the participants' performance during the target-focused activity (for the non-word activity group) on their subsequent reading behavior to determine whether they, having identified gaps in their vocabulary through the activity, allocate increased attentional resources to unlearned words during the second part of the main reading. To this end, we conducted an analysis to ascertain whether items marked as "incorrect" during the fill-in-the-blank activity but marked as "correct" during the vocabulary test (i.e., incorrect in the fill-in-the-blank activity–correct in the vocabulary test) significantly attract learners' attention compared with other type of item, namely correct–correct. The correct–incorrect items (i.e., items that were marked as "correct" during the fill-in-the-blank activity but later as "incorrect" during the vocabulary test) and Incorrect–Incorrect items were excluded. Unlike the correct–correct items, these represent an unstable link between the target non-word form and its meaning, making it hard to predict the reading patterns in the second reading task compared with the first one. For this analysis, we used a proportional measure of reading time, where reading time was divided by the number of characters for each item (ranging from 3 to 8). This approach was taken to account for the possibility that reading times could be influenced by the item's length (Hyönä & Olson, 1995; Just & Carpenter, 1980; Kliegl et al., 1983). Figure 8 below illustrates the average response time for target non-words (ratio), divided by the number of characters for each item.

We created a model that incorporated items (incorrect–correct, correct–correct, and incorrect–incorrect, dummy coded), categorized according to the correctness of each target item, derived from the fill-in-the-blank activity and vocabulary test (using the semantic scoring and exact scoring methods). In the model, these items are treated as fixed effects. The model initially included random effects for both participants and items (defined as real English translation of each target non-word, such as "house" for the item "glabe") with intercepts and slopes. However, due to convergence issues, we simplified the random effects structure, retaining only the intercepts for both

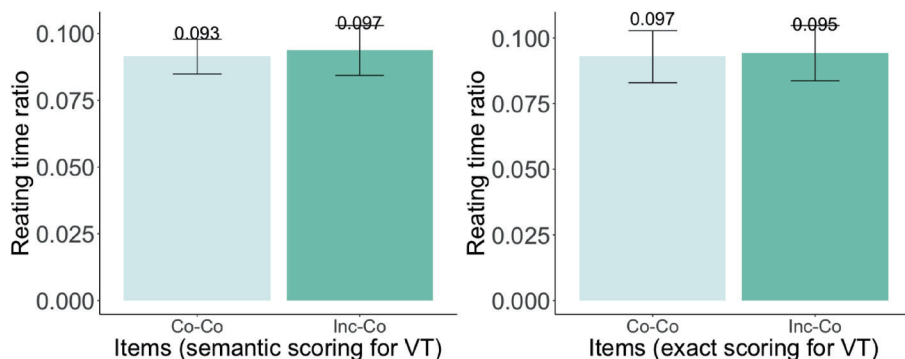


Figure 8 *Average reading time of items divided by the number of characters for the the fill-in-the-blank activity and vocabulary test accuracy (under the semantic scoring and exact scoring methods). The error bars show bootstrapped 95% confidence intervals.*

participants and items. The dependent variable in this model is the log-transformed reading time divided by the number of characters for each item.

The results obtained using the semantic scoring method showed no statistically significant differences in the response times between correct–correct and incorrect–correct items ($\beta = 0.005$, $t = 0.43$, $p = 0.67$). These findings suggest that target items that were not successfully recalled during the word-focused activity did not elicit a significant increase in learners’ attention during subsequent reading tasks.

Likewise, when employing the exact scoring method, the regression results exhibited a comparable trend. There were no significant differences in reading time between correct–correct and incorrect–correct items ($\beta = -0.018$, $t = -1.24$, $p = 0.22$). To sum up, the regression outcomes using both the semantic category and exact scoring methods indicate that participants, prompted by the target-focused activity to recognize a lack of knowledge in the meaning of those words, did not demonstrate an increased focus on those words when provided with an opportunity to revisit the English text.

Summary of The Findings

We investigated how a word-focused activity involving target items influences learners’ reading behavior and subsequent vocabulary learning. Two distinct word-focused activity conditions were established: one involving target non-words (non-word activity) and the other involving real words (real word activity). In terms of reading behavior, the results revealed no significant differences between the non-word activity group and the real word activity groups in their reading of the English text during the rereading task. Furthermore, there was no notable distinction in the processing of target non-words during the second reading task. Although the recorded times showed no difference, interacting with target non-words in the non-word activity produced a learning advantage for remembering the meanings of those non-words compared with the real word activity.

To ascertain whether the awareness of a lack of knowledge about new vocabulary during the word-focused activity influenced the processing of those words during repeated reading task, we explored whether the items marked as “incorrect” during the activity but later successfully recalled during the vocabulary test were processed for significantly longer than items marked as “correct” in both the activity and vocabulary test. However, the results showed no such difference in response time among those cases. These findings suggest that the engagement with the word-focused activity after the initial reading had little impact on altering the learners’ subsequent processing of items that had not yet been learned.

Discussion

We examined the potential of a post-reading word-focused activity to improve learners’ awareness of gaps in their target vocabulary knowledge, as suggested by De Vos et al. (2019). The goal was to determine if this increased awareness would lead to heightened attention and improved memory of the meanings of those words.

Ninety-five L1 Korean speakers of English read the English text and then responded to a word-focused activity in the format of a fill-in-the-blank activity. The participants were divided into two conditions: one group interacted with target non-words (non-word activity group), while the other group interacted with real words (real word activity group) as a control condition. Following the word-focused activity, the participants reread the English text and completed a vocabulary test that measured their knowledge of the meanings of the newly introduced vocabulary.

According to Swain’s output hypothesis (1985, 1993, 1995, 1998), we assumed that participants engaging with the target items during the word-focused activity would recognize gaps in their knowledge of new vocabulary that they had encountered in the previous reading task. This awareness was expected to prompt them to dedicate more time to those unfamiliar items during subsequent reading tasks, leading to better performance in the subsequent vocabulary test compared with participants who did not interact with the target items in the word-focused activity (i.e., the real word activity group).

Contrary to my initial hypothesis, the results revealed no significant differences in the processing of the entire text and the 16 target non-words embedded in sentence contexts between the non-word activity and real word activity groups. Surprisingly, even when we categorized the items according to the learners’ performances during the word-focused activity involving target non-words and the vocabulary test, incorrect–correct items (items that were marked as “incorrect” during the word-focused activity but successfully recalled in the vocabulary test) did not significantly differ from the correct–correct items (items that were marked as “correct” in both the word-focused activity and the vocabulary test) in the response times during the second reading task. This suggests that a lack of knowledge in the meanings of new vocabulary, induced by engagement with the fill-in-the-blank activity, did not necessarily result in the participants spending extra time reading items that had yet to be learned, even when given the opportunity to read the English text again.

Despite these findings, however, participants engaging with novel non-words during the target-focused activity showed better ability to remember the non-words’ meaning,

or at least their semantically relevant aspects, compared with their counterparts in the vocabulary test. This result aligns with previous research demonstrating the benefits of post-reading word-focused activities on the learning of newly learned word–definition pairs (e.g., De Vos et al., 2019; Nguyen & Boers, 2019; Rassaei, 2019).

So, why did the non-word activity group fail to exhibit increased attention to target items during the second reading task? One plausible explanation stems from the lack of feedback on the learners' retrieval attempts during the fill-in-the-blank activity. Specifically, the participants received no feedback about the accuracy of their choices after submitting responses in the activity. Therefore, it is conceivable that the meanings of the recalled non-words during the fill-in-the-blank activity were, in fact, inaccurate. Without knowing that they had formed inaccurate associations between the to-be-learned items and their meanings, the learners might not have perceived the need to pay more attention to the non-words during subsequent repeated reading tasks. This lack of attention could explain the absence of the benefits of engaging with target non-words during the fill-in-the-blank activity, followed by the initial reading task. This finding underscores the potential value of providing feedback to learners, enabling them to discern what they do and do not know. Awareness of inaccuracies in their knowledge could influence learners' reading behavior during subsequent input, prompting increased attention to unknown vocabulary and, consequently, leading to a more robust memory trace of new words. Further investigation into this issue can shed light on the optimal approach for learning new vocabulary through post-reading word-focused activity.

Another explanation could be linked to the positive impact of repeated reading on vocabulary learning (e.g., Horst & Meara, 1999; Pavia et al., 2019; Webb & Chang, 2012). Recall that participants in both the non-word activity and real word activity conditions were instructed to read the English text twice. Given that repeated exposure to textual input can facilitate word learning (Pavia et al., 2019), this phenomenon might not only have counteracted the possible negative effects of engaging with real words but also provided learners in the real word activity group with nearly an equal chance to retain lexical knowledge, similar to learners in the non-word activity group.

Implications

Theoretical Implications of The Findings

Swain (1985, 1993, 1995, 1998) suggested that the benefits of a word-focused activity for vocabulary learning can be attributed to the “noticing” function of the word-focused activity. In short, the task of a word-focused activity requiring learners to recognize and recall the accurate meaning of a non-word's meaning would help learners differentiate what they know versus what they do not know. This would, in turn, prompt them to allocate attentional resources to the to-be-learned target items that involve making contextual inferences and synthesizing multiple diverse cues if they revisit the input. While three previous studies have explored the “noticing” function of word-focused activities (De Vos et al., 2019; Izumi, 2002; Russell, 2014), they have relied solely on qualitative data obtained through either note-taking or surveys to gauge the participants' awareness of insufficiencies in the newly learned vocabulary. Therefore, the present study distinguishes itself as the first to provide empirical and quantitative data on

the noticing function of word-focused activities in vocabulary learning, contributing to the L2 vocabulary acquisition literature.

Practical Implications of The Findings

The current study demonstrated that engagement with a text-based word-focused activity positively affects the uptake of new words from reading, even though it has little impact on increasing attention to those items during the second reading task. This finding holds significance for L2 instructors and material developers, emphasizing the value of implementing text-based word-focused activities to boost vocabulary learning from reading. Moreover, we speculate that the limited impact on increased attention during the second reading task, despite engaging with target non-words, could be attributed to the absence of feedback in the post-reading activities. As a recommendation, we suggest that L2 instructors and material developers should incorporate feedback for the learners' responses to help them understand what they know and what they do not know. Lastly, despite no significant differences in reading times for items that were barely recalled compared with those successfully retrieved on the second reading, the fact that engaging in a word-focused activity involving target non-words led to better retention may be attributed to the accumulation of additional semantic cues during the second reading task. Therefore, this finding can provide positive evidence in favor of revisiting the reading task after completing word-focused activities (Horst & Meara, 1999; Pavia et al., 2019).

Limitations

Despite the important findings and implications mentioned above, this study is not without limitations. First, the participants did not receive any feedback on their performance during the word-focused activity. It is possible that the benefits of the word-focused activity for vocabulary learning can be more pronounced when learners are, at least, informed of whether the items they chose were correct or not during the activity. Having a clear picture of the items they know or not will help raise learners' awareness of the erroneous items when they revisit the written text. Therefore, it is advisable for future researchers to provide feedback during the activities to better understand the cognitive mechanisms of the word-focused activity during vocabulary uptake from reading. Moreover, the present study did not consider the potential role of motivation in learning new L2 vocabulary. For instance, different outcomes might be observed if the participants were less proficient learners of English who were more motivated to learn new vocabulary through post-reading activities than the current participants. Similarly, learners might be more motivated if the target items consisted of actual English words (of very low frequency) rather than novel non-words. Next, we used only one type of word-focused activity, specifically filling in blanks with the correct item from a wordlist. However, given the variety of word-focused activities used in previous studies, such as composing a summary of the reading text involving target items, it would be useful to explore how the impact of interacting with an activity following a reading task on the processing of new vocabulary and its retention might differ across various types of post-reading

activities. Lastly, learners' engagement with the English text was only measured in terms of reaction times. Future researchers could diversify the way in which they look at learners' reading behavior by using other online techniques, such as eye-tracking, which has emerged as a useful tool to offer an online real-time account of learners' attention to the target vocabulary (Fievez et al., 2023).

Conclusion

This study examined the underlying mechanisms of post-reading word-focused activities on learners' noticing the hole in their knowledge of new L2 vocabulary encountered during reading. Using a self-paced reading paradigm, we focused on whether engaging with novel non-words during the word-focused activity after the initial reading task would draw learners' attention more towards items yet to be learned during the subsequent reading task, compared with a word-focused activity involving real words. The results showed a trend toward significance regarding the benefits of engaging with the activity involving target non-words on recalling the non-word's meaning ($p = 0.06$). Additional research with greater statistical power or replication is needed to confirm this potential effect. In terms of processing target non-words, however, we observed no significant difference in the processing of target non-words during the second reading task between learners engaging with non-words and those with real words during the word-focused activity, and also in the processing of items yet to be learned versus items already acquired.

It is important to note a few limitations in our research, including the absence of feedback during post-reading activities, the role of motivation, the use of a single type of word-focused activity, and measuring reaction time only for the processing of target items during the second reading task. Therefore, it would be prudent to generalize the findings of our study. We recommend that future researchers address the limitations to uncover the cognitive mechanisms underlying the benefits of word-focused activities following reading.

References

- Bates, D., Maechler, M., Bolker, B., Walker, S., Christensen, R. H. B., Singmann, H., H., Dai, B., Scheipl, F., Grothendieck, G., Green, P., Fox, J., Bauer, A., Krivitsky, P. N., Tanaka, E., Jagan, M., & Bolker, M. B. (2015). Package 'lme4'. *Convergence*, 12(1), 2.
- Bordag, D., Kirschenbaum, A., Tschirner, E., & Opitz, A. (2015). Incidental acquisition of new words during reading in L2: Inference of meaning and its integration in the L2 mental lexicon. *Bilingualism: Language and Cognition*, 18(3), 372–390.
- De Vos, J. F., Schriefers, H., & Lemhöfer, K. (2019). Noticing vocabulary holes aids incidental second language word learning: An experimental study. *Bilingualism: Language and Cognition*, 22(3), 500–515.
- Fievez, I., Montero Perez, M., Cornillie, F., & Desmet, P. (2023). How do learners use a CALL environment? An eye-tracking study. *Language Learning & Technology*, 27(1), 1–22.

- Fine, A. B., Jaeger, T. F., Farmer, T. A., & Qian, T. (2013). Rapid expectation adaptation during syntactic comprehension. *PloS one*, 8(10), e77661.
- Hoot, B., & Leal, T. (2023). Resilience and vulnerability of discourse-conditioned word order in heritage Spanish. *Applied Psycholinguistics*, 44(5), 668–698.
- Horst, M., & Meara, P. (1999). Test of a model for predicting second language lexical growth through reading. *Canadian Modern Language Review/Revue Canadienne des Langues Vivantes*, 56, 308–328.
- Hyönä, J., & Olson, R. K. (1995). Eye fixation patterns among dyslexic and normal readers: Effects of word length and word frequency. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21(6), 1430.
- Izumi, S. (2002). Output, input enhancement, and the noticing hypothesis: An experimental study on ESL relativization. *Studies in Second Language Acquisition*, 541–577.
- Just, M. A., & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological Review*, 87(4), 329.
- Kliegl, R., Olson, R. K., & Davidson, B. J. (1983). On problems of unconfounding perceptual and language processes. In K. Rayner (Ed.), *Eye movements in reading: Perceptual and language processes* (pp. 333–343). Academic Press.
- Marsden, E., Thompson, S., & Plonsky, L. (2018). A methodological synthesis of self-paced reading in second language research. *Applied Psycholinguistics*, 39(5), 861–904.
- Mohamed, A. A. (2018). Exposure frequency in L2 reading: An eye-movement perspective of incidental vocabulary learning. *Studies in Second Language Acquisition*, 40(2), 269–293.
- Mulder, E., van de Ven, M., Segers, E., Krepel, A., de Bree, E. H., de Jong, P. F., & Verhoeven, L. (2021). Word-to-text integration in English as a second language reading comprehension. *Reading and Writing*, 34, 1049–1087.
- Nguyen, C. D., & Boers, F. (2019). The effect of content retelling on vocabulary uptake from a TED talk. *TESOL Quarterly*, 53(1), 5–29.
- Pavia, N., Webb, S., & Faez, F. (2019). Incidental vocabulary learning through listening to songs. *Studies in Second Language Acquisition*, 41(4), 745–768.
- Pellicer-Sánchez, A. (2016). Incidental L2 vocabulary acquisition from and while reading: An eye-tracking study. *Studies in Second Language Acquisition*, 38(1), 97–130.
- R Core Team. (2018). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. <https://www.r-project.org>
- Rassaei, E. (2017). Effects of three forms of reading-based output activity on L2 vocabulary learning. *Language Teaching Research*, 21(1), 76–95.
- Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, 124(3), 372–422.
- Roberts, L. (2015). Self-paced reading and L2 grammatical processing. In A. Mackey & E. Marsden (Eds.), *Advancing methodology and practice* (pp. 70–84). Routledge.
- Russell, V. (2014). A closer look at the output hypothesis: The effect of pushed output on noticing and inductive learning of the Spanish future tense. *Foreign Language Annals*, 47(1), 25–47.
- Swain, M. (1985). Communicative competence: Some roles of comprehensible input and comprehensible output in its development. In S. Gass & C. Madden (Eds.), *Input in second language acquisition* (pp. 235–253). Newbury House.

- Swain, M. (1993). The Output Hypothesis: Just speaking and writing aren't enough. *The Canadian Modern Language Review*, 50, 158–164.
- Swain, M. (1995). Three functions of output in second language learning. In G. Cook & B. Seidlhofer (Eds.), *Principles and practice in applied linguistics: Studies in honour of H.G. Widdowson* (pp. 125–144). Oxford University Press.
- Swain, M. (1998). Focus on form through conscious reflection. In C. Doughty & J. Williams (Eds.), *Focus on form in classroom second language acquisition* (pp. 64–81). Cambridge University Press.
- Swain, M. (2005). The output hypothesis: Theory and research. In E. Hinkel (Ed.), *Handbook of research in second language teaching and learning* (pp. 495–508). Routledge.
- Webb, S., & Chang, A. C. (2012). Vocabulary learning through assisted and unassisted repeated reading. *Canadian Modern Language Review*, 68(3), 267–290.
- Yang, Y., Shintani, N., Li, S., & Zhang, Y. (2017). The effectiveness of post-reading word-focused activities and their associations with working memory. *System*, 70, 38–49.
- Zhang, P., & Graham, S. (2020). Vocabulary learning through listening: Comparing L2 explanations, teacher codeswitching, contrastive focus-on-form and incidental learning. *Language Teaching Research*, 24(6), 765–784.

Appendix A

A Pairing of real words and target non-words in Story A and Story B.

Real words	Non-words in Story A	Non-words in Story B
prisoner	redaster	blaunt
village	melnawg	redaster
ring	salp	nuse
baby	semz	norg
son	mer	salp
mother	flugit	slagum
food	norg	mer
bowl	nuse	semz
clothes	blaunts	nagids
house	glabe	melnawg
noise	trobe	glabe
night	flern	trobe
worker	zamper	tombat
garden	tombat	zamper
hungry	slagum	flugit
birth	nagid	flern

B. Comprehension test questions
The story is set in Africa.
The boys did not seem to receive proper care.
The woman was dressed well.
No one took care of the woman.
The old woman dressed Hugo.
Hugo knew where he came from, though people around him didn't say anything about it.
Hugo and the boys were aware that it would be worse to live alone in the outside world.
All boys did the same chores, regardless of their age.
After lunch, it was the time for the boys to pick the vegetables.
Dreaming of a brighter future made Hugo feel better.
Although the boys knew that the master lied to them, they stayed quiet.
While Hugo was washing the dishes, the other boys were playing outside.
The old woman took Hugo to the punishment room.
The boys never saw Hugo crying even though he had extra work to do.
The master sent the boys to the punishment room for no reason.
Maria took the boys on outings on the weekends.
Hugo wished a nice family would adopt him.
The master had some bad news for Hugo.
In two days, Hugo would leave and start a new life.
Hugo needed more bags because he had a lot of things to pack.
Hugo was waiting outside when the couple drove up in their car.
The couple was surprised to see the poor conditions that the boys lived in.
Now Hugo had his own room.
Hugo was so happy about his new life in the couple's house.
Hugo didn't miss anything about his old life.