The Effect of Different Vocabulary Coping Strategies on Incidental Vocabulary Acquisition: An Eye Tracking Study

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ABSRACT

Studies have shown that vocabulary can be acquired in second language reading, but researchers have not explicitly examined which vocabulary coping strategies lead to higher rates of vocabulary learning. This study aims to fill this gap by examining the effect of various strategies using eye tracking and navigation tracking. The strategies examined include reviewing the context surrounding the novel word, dictionary use, and simply reading on. Scores of an unannounced vocabulary exam with 16 pseudowords from the text were used to examine how the scores may have been correlated to the eye movement and navigation data. The data examined included whether and how much target words were fixated on, contexts were read and reviewed, and dictionaries entries were viewed. The findings showed that making regressions to review t.he context can lead to correctly identifying and recalling word meaning, as can looking up words in the dictionary. Using both strategies (reviewing the context and dictionary use) led to the highest chances of word meaning recall. However, several measures were not significant, as there are confounding variables, such as the context of the word and learners' working memory scores. Implications for educators and researchers are discussed.

INTRODUCTION

Research suggests that vocabulary can be learned incidentally by L2 learners while reading (e.g., Huckin & Coady, 1999; Teng, 2019a; Waring & Takaki, 2003), although the number of words acquired is quite limited (Hulstijn & Laufer, 2001; Laufer, 1991). However, what strategies lead to higher rates of acquisition is a little explored area. There are a variety of strategies readers can use when they come upon novel lexical items. Learners can inspect the surrounding text to guess the meaning from context; they could check the meaning in a dictionary or other source; or, they could simply read on without making efforts to infer or confirm the meaning (Cutting & Scarborough, 2006; Hulstijn, Hollander, & Greidanus, 1996; Laufer, 1997). Some learners may be overly dependent on a certain strategy despite the context (Kobayashi, 2007; Prichard, 2008; Prichard & Atkins, 2021). Part of this could be due to the instruction of misinformed L2 teachers; some encourage the use of dictionaries as much as possible and others ban their use in class (Prichard & Atkins, 2021; Tang, 1997).

Studies suggest that the ideal vocabulary coping strategy depends on several factors (Hulstijn, 1993; Prichard, 2008). For example, the quality of the context (Teng, 2019a) and the reader's lexical coverage greatly influences whether learners are able to infer meaning without a dictionary (Huckin & Bloch, 1993). Considering that inaccurate inferences not only hinder vocabulary acquisition but also reading comprehension, using a dictionary (Luppescu & Day, 1993) or marginal glosses (Khezrlou, Ellis, & Sadeghi, 2017) could lead

to better outcomes. However, looking up too many words may exhaust working memory and distract the learner from their greater reading purpose. If the novel word is not essential to one's reading objective, it may be advisable to just continue reading without looking up the word (Prichard & Atkins, 2021).

While research suggests that the ideal vocabulary coping strategies may depend on multiple variables, prior studies have not examined the strategies of readers who had the option of using a dictionary and the effect on vocabulary retention. This study aims to fill this gap by analyzing Japanese L2 readers' vocabulary strategies through eye tracking and comparing this with their post-reading vocabulary scores. Although knowing a word involves several aspects, such as spelling and usage (Nagy & Scott, 2000), this study focuses on receptive knowledge of the word and its meaning. The research follows up on a previous study of vocabulary coping strategies that focused on reading comprehension (Prichard & Atkins, 2021).

VOCABULARY COPING STRATEGIES AND INCIDENTAL VOCABULARY LEARNING

Incidental vocabulary learning while reading can be defined as when readers' primary focus is on meaning-focused comprehension and where learning novel vocabulary is a "by-product" (Hulstijn, 2003, p. 362). The research on incidental vocabulary acquisition has been expansive, but how different vocabulary coping strategies, including dictionary use, affect word meaning recall has not been explicitly explored.

As noted above, readers have several strategies they can use when they encounter unknown lexical units. Research on these strategies will be discussed separately in detail below. However, it is important to note that the strategies are not mutually exclusive (Prichard & Atkins, 2021). For example, readers may try to infer the meaning and then choose either to use the dictionary (to get the meaning or confirm inferences) or to read on (e.g., if they feel a partial inference or a rough guess is enough). In addition, Huckin and Bloch (1993) discuss "late bloomers" (p. 158) -- words that were initially ignored by the reader but are eventually figured out from context.

Looking up Words

Dictionary use is a frequently used strategy by L2 readers. In one study (Koyama & Takeuchi, 2007), Japanese participants looked up 3.79% of the running words in texts. Among Japanese learners who had a mean coverage of 92.7% of the text, learners looked up an average of 1.7% of the running words, which raised their coverage to 94.4% (Prichard & Matsumoto, 2011). However, in another study (Prichard & Atkins, 2021), learners used the dictionary link almost 80% of the time for novel words even though their coverage of the text was already 96%.

Numerous studies have shown how looking up words can aid in acquisition (e.g., Hulstijn, Hollander, & Greidanus, 1996). Dictionary use can enable readers to identify the exact meaning, which is often unreliable when making inferences from context (Laufer, 1997). Moreover, looking-up a word usually means that the reader is spending more time processing it, and the Involvement Load Hypothesis suggests that this increased mental effort in identifying meaning can lead to better retention (Hulstijn & Laufer, 2001; Liu et al., 2014). However, if dictionary use is easy and fast, such as with online dictionaries, it could lead to shallow processing (Koyama & Takeuchi, 2007) and perhaps lower odds of retention.

Try to Infer Meaning

Making efforts to infer meaning is another frequently used strategy (Fan, 2003). Learners with higher proficiency more often reported guessing word meaning as opposed to

dictionary use (Gu & Johnson, 1996; Hulstijn, 1993), perhaps because high coverage allows readers to better understand the context, enabling them to better infer meaning (Hammadou, 1991). Another possibility is that not relying solely on dictionary use suggests metacognitive competence and/or more fluent reading, which reflects or *leads* to more proficiency (Teng, 2020).

While words can occasionally be acquired through inferences, several factors greatly affect the ability of learners to acquire novel words from context, as discussed below (e.g., Teng, 2019a). It is important to note that even if meaning is correctly inferred, the word will often not be acquired unless the word occurs in the text repeatedly (Uchihara, Webb, & Yanagisawa, 2019) and the word is retrieved later through review (van den Broek et al., 2018).

Reading on

Ignoring unknown vocabulary has been defined as reading on without confirming the meaning (Prichard & Atkins, 2021). This includes "pothole" cases observed by Huckin and Bloch (1993, p. 168), where learners simply pass over novel words without making inferences. This was the case nearly 16% of the time. Similarly, Warren and colleagues (2018) found that readers ignored text-based glosses exactly one in five times. However, other studies have found that novel words were rarely ignored (Elgort et al., 2018). In cases where clear context cues were not present and half the words were task irrelevant, participants read on without using a dictionary nearly one in five times (Prichard & Atkins, 2021).

It has been argued that it is advantageous to avoid dictionary use if an unknown word is not relevant to one's reading or learning objective (Hulstijn, 1993; Paribakht & Wesche, 1997; Prichard, 2008). However, few words will be likely acquired if novel words are often skipped over.

Variables Influencing Vocabulary Acquisition

Incidental vocabulary acquisition and the efficacy of various coping strategies depend on numerous factors (Uchihara et al., 2019), including word characteristics (e.g., length, cognateness), text characteristics (e.g., complexity, length), and learner variables (e.g., proficiency, motivation, working memory). While this study is not focused on examining each of these variables, they cannot not be ignored.

The number of uses

Frequent occurrences of a word in a text means there is a well-rounded context for the meaning of the word to be accurately inferred and more chances that the meaning of form will be stored to long term memory (Webb, 2007). Multiple uses may also suggest that the word is worth noticing and learning (Hulstijn, Hollander, & Greidanus, 1996).

Whether a word occurred one or three times in a text did not make a difference (Hulstijn et al., 1996), and researchers have suggested that vocabulary may need to be encountered many more times than that for reliable incidental acquisition. The number of occurrences has been suggested to be six (Rott, 1999), eight (Horst et al., 1998), more than ten (e.g., Teng, 2019a; Webb, 2007), or more than 20 (Waring & Takaki, 2003). Meta-analysis confirmed a moderate correlation between repetition and acquisition (Uchihara, Webb, & Yanagisawa, 2019). However, this depends on other factors, such as the context (Teng, 2019a) and how recently the word was encountered (Elgort et al., 2018). Most studies on this variable, other than Teng (2019b), have not involved the option to look up words.

One's objective

Needless to say, people have various reading objectives; L2 learners may read simply because they have to (for class), or they may want to develop reading fluency or acquire or reinforce language aspects (e.g., vocabulary, grammar). They also may have authentic reasons such as reading for pleasure, getting information, or communicating. Their purpose often influences whether the exact meaning of an unknown word needs to be recognized or if a word needs to be learned. Research suggests that L2 readers more often make use of electronic glosses if the word is related to their needs, such as vocabulary connected to their future career (Lenders, 2008) or their reading task (Prichard & Atkins, 2021), or when they are reading to develop vocabulary (Liu et al., 2019). Learners may more often consult electronic glosses if instructed to by the teacher, and this may lead to more long-term retention (Khezrlou et al., 2017).

The quality of the context

Few words are presented in contexts rich enough to enable accurate inferences. Webb (2008) suggests that the quality of the context may be even more important than the number of times the word is encountered. While L2 materials may be manipulated to enable accurate inferences, the meaning of unknown words in authentic texts is often opaque (Hulstijn et al., 1996) and some contexts may be misleading (Beck, McKeown, & McCaslin, 1983).

Text difficulty and lexical coverage

Knowing at least 95% of the running words in a text is key to comprehending novel lexica, and this is partially because the less coverage a reader has the more difficult it is to guess vocabulary from context (Hu & Nation, 2000; Laufer, 1992; Laufer, & Ravenhorst-Kalovski, 2010). Therefore, readers below this mark tend to use the dictionary more, and learners in the 90-95% coverage range benefited from using a dictionary, in terms of comprehension (Prichard & Matsumoto, 2011). Learners below 90% coverage may struggle not only with inferring meaning of unknown words, but also with dictionary use since looking up numerous words can take up working memory and contribute to cognitive load (Dang et al., 2013; Ranalli, 2013). If a learner is struggling to infer unknown vocabulary and to comprehend the text, they are much less likely to retain the meaning of any words that are looked up. This may be compounded by other factors, such as a low working memory, a lack of background knowledge, or a long and complicated text (Elgort et al., 2018).

The dictionary or gloss

Resource variables include the following: bilingual or monolingual (authentic or simplified); the presence of images; and, paper, electronic, or online. Online resources can be further divided into those that are online dictionaries that are searched (key-in), definitions accessible with a mouse click, and electronic glosses (Liu et al., 2014). The type of resource affects its use and the efficacy of looking up words.

Certain resources take more time and effort to use (Chen, 2010; Koyama & Takeuchi, 2007), and this could use up working memory and hinder inferencing and retention. In contrast, marginal glosses are quick and easy to use, and meta-analysis suggests that novel words can be acquired through glosses (Yun, 2011).

On the other hand, with dictionaries that take longer and more effort to use, readers may interact with the text and try to infer meaning from context rather than immediately look up words (Kobayashi, 2007). Moreover, as noted above, the Involvement Load Hypothesis suggests that increased mental effort in identifying meaning can lead to increased retention (Hulstijn & Laufer, 2001). Nevertheless, studies have not always shown an advantage for either electronic or paper dictionaries (see Dziemianko, 2010 for an overview).

Learner variables

A meta-analysis suggested that older learners benefit more from repeated encounters compared to younger learners (Uchihara et al., 2019). Readers lacking working memory may struggle with strategies contributing to cognitive load, such as inspecting context cues or looking up words (Dang et al., 2013; Ranalli, 2013).

L2 readers' dictionary skills likely affect the use and efficacy of looking up words (Ranalli, 2013). Learners may lack ability to use a dictionary efficiently, and they may identify the wrong definition (Luppescu & Day, 1993). Learners also may lack metacognitive skills, overly relying on a certain strategy despite the context.

Eye Tracking Research for Novel Vocabulary Processing

Studies on vocabulary coping strategies have tended to rely on self-report protocols, which may not always be accurate (Qian, 2002) as participants may be unaware of their strategy use or reply based on what they perceive is the ideal response (Prichard & Atkins, 2019). Tracking links followed to dictionary definition (e.g., Hulstijn, 1993, Prichard, 2008) is a valid method to check which words are looked up, but this cannot be used to evaluate how readers process novel lexical units, the surrounding context, or the dictionary definitions.

An increasing number of L2 studies have utilized eye tracking (Conklin & Pellicer-Sánchez, 2016; Godfroid, 2019) since eye movements "reflect moment-to moment cognitive processes" (Rayner, 1998, p. 372) and reflect reading strategy usage (Hyönä & Kaakinen, 2019). Godfroid and colleagues (2013) utilized eye tracking as L2 readers processed pseudowords presented both with and without context cues. They found that the presence of context cues did not lead to more frequent retention of pseudowords on an unannounced vocabulary exam. Words in which the meaning was recalled were fixated on longer than other pseudowords. Dolgunsöz's study (2016) revealed that second pass time on target words correlated with post-reading vocabulary recall scores, but only for more proficient learners with more vocabulary knowledge.

Pellicer-Sánchez (2016) investigated how learners read fictional texts in which novel words were used repeatedly. Corroborating L1 research, the measures tended to show that L2 readers processed novel words more quickly after repeated encounters, and words recalled on the posttest were fixated on longer while reading.

Elgort and colleagues' study (2018) was similar to that of Pellicer-Sánchez (2016), but an authentic non-fiction text and real words (not pseudowords) were used. The eye tracking measures suggested that learners became familiar with the target words after five to seven instances. Regressions-in (regressions back to the target word) decreased by the fifth occurrence. However, longer gaze durations and more frequent regressions suggested word-meaning association was not automatic and reading these words was still effortful.

Researchers have also utilized eye tracking to examine the attention readers gave to dictionary and gloss definitions. Warren and colleagues (2018) used eye tracking to determine the amount of attention given to pseudowords in the text (3 occurrences) and glosses in three conditions (text-only, picture-only, and multimedia glosses). They found that the picture-only condition led to the best recall of meaning. Increased focus on pseudowords in the text and glosses (total fixations and total fixation duration) led to better form and meaning recall. The amount of attention paid to the picture or definition in the gloss had no effect, however. In contrast, Lew and colleages (2018) found that the longer L2 readers fixated on the definitions and illustrations, the higher chances of meaning retention. However, this study only included ten participants, and it did not factor in readers' attention to the target words in the text. Finally, Liu and colleagues (2019) used eye tracking to ascertain that readers devoted more attention to glosses when focusing on vocabulary acquisition than when focusing on comprehension.

An examination of the effect of online vocabulary coping strategies with the option of dictionary use had not been explicitly examined until a recent study by the authors (Prichard & Atkins, 2021). Though the article did not focus on vocabulary acquisition, eye tracking was used to evaluate whether learners looked up words (pseudowords), made regressions to re-examine the word, or just read on. Only half of the words were relevant to the readers' research task, and half had clear context cues.

It was found that learners used a dictionary for 79% of the time (Prichard & Atkins, 2021). Two-thirds of the time they accessed the dictionary without making a regression to try to work out the meaning of the text. When the target word was in the middle of the sentence, they only read until the end of the sentence 37% of the time. They made regressions after fixating on the pseudoword just 19% of the time. In 8% of the cases, they did not make a regression or use a dictionary. In cases where there were no context cues, learners avoided dictionary use 20% of the time, suggesting that they chose to ignore the unknown word and read on. The results revealed that looking up words had a negative correlation with comprehension but fixating longer on the definitions in the dictionary link of relevant words was beneficial. Reviewing sentences after fixating on the novel words and avoiding fixating on irrelevant novel words correlated with task performance.

However, data involving the vocabulary test was not analyzed in this study as the main focus was on comprehension, not incidental vocabulary acquisition. Therefore, this study uses the eye tracking results of the 2020 study to see how they affected the vocabulary test results.

METHODS

This is the second of two studies on the eye and navigation tracking data of high-intermediate Japanese learners of English while researching a specific topic from a website. The text contained 16 pseudowords, which were presented with and without context cues and in passages either relevant or irrelevant to the assigned research task. While the main focus of the original study (Prichard & Atkins, 2021) concerned the effect of vocabulary coping strategies on task-based reading performance, the focus of this article is to examine the relationship between the vocabulary strategies and the results of an unannounced vocabulary quiz.

Participants

Sixty-three students in their second year at a Japanese university participated in the study. The participants were relatively proficient for Japanese standards; their mean four-skill GTEC score was 570.28 ($SD = 18.12$).

Equipment

A Tobii Pro Spectrum eye tracker was used. Its sampling rate is 150 Hz, and its reported accuracy is 0.3°. The tracker is an integrated eye tracker and has a 23.8-inch monitor with a resolution of 1920×1080 pixels. Participants were positioned 65 cm from the monitor. Nine-point calibration was used and validated with four points.

Materials

The text concerned mosquito killing contests in Estonia and Taiwan. Participants were asked randomly to research the contest in one of the countries. After a short introduction, the text included sections on a mosquito killing contest in Estonia, a contest in Taiwan, about the winners in Estonia, and about the champion in Taiwan. A table of contents showed the sections, and the four sections were also shown at the top of each page, with the

current page highlighted. The content and language used was tightly controlled. The four sections each had 100 words, divided into four paragraphs of two sentences each.

This study involved pseudowords so that the researchers could ensure that the target words were not known. The target words were nouns and were in the second sentence in each of the body paragraphs. All the other words in the text were common words, which piloting suggested would all be known to the learners. This meant that participants would have 96% coverage of the body text.

The target words were hyperlinked to a dictionary-like page, which provided two short English definitions along with a Japanese one. Phonetic transcriptions and the part of speech were not noted.

There were four target words in each of the four conditions:

- irrelevant, without context
- irrelevant, with context
- relevant, without context
- relevant, with context

Eight of the 16 target words were in sections on Estonia, and eight were in the Taiwanese sections. Therefore, only half of the pseudowords were task relevant. Half of the target words had clear context cues (the meaning could be inferred at least 75% of the time in piloting), and others had no context cues. Four of the cues included a synonym after the target word (e.g., "... [*pseudoword*], and this [*synonym*] was...."*).* Two target words could be inferred by using examples (e.g., *Yuwen had placed her traps around her thervans, including pigs and chickens.*) Two target words were defined in the text (e.g., "[*known word*], also called [*pseudoword*]…,").

To maximize conditions for eye tracking, the text was in a size 52 font and the line spacing was 3.2. It was presented over 17 pages with a single paragraph on each. A link at the bottom of each page was clicked to go to the next page.

Vocabulary test

The vocabulary task listed the 16 pseudowords in alphabetical order. Participants could write a synonym match or the definition of the word in English or Japanese. Productive knowledge of form (i.e., spelling) was not included.

Working memory test

One's working memory can affect vocabulary strategy use and one's ability to retain vocabulary, so a shortened version of the Japanese reading span test (JRST; Osaka & Osaka, 1992) was given to a subgroup (n = 41) of the participants in order to account for this variable.

Procedures

Participants read the instructions and completed the pre-reading task in order to ensure focus on the research task. They were told they had 15 minutes to read but that they could finish early. Participants were informed that they could click on words to access the dictionary if they wished. It was explained that they needed to click the link to go to the next page, but they could not go back to review the pages visited. They could not take notes. After they finished the reading and writing task, they were given the unannounced vocabulary test.

Analyses

Vocabulary strategies

The different coping strategies were coded, as described in detail in the original study (Prichard & Atkins, 2021). Dictionary use could be identified as the links followed to the dictionary page were tracked. The total fixation duration on the dictionary definitions was also tracked to analyze the degree of attention on the dictionary entries. For target words without context cues, the strategy of ignoring unknown words was coded where participants did not access the dictionary. Reviewing the context was coded when a participant made a regression to fixate on the target sentence after fixating on the target word.

Vocabulary retention

One point was awarded if the meaning attached to each pseudoword was written correctly in Japanese or English, regardless of spelling. Both task-relevant and irrelevant words were scored. As there was no delayed post-test, scoring correctly did not necessarily suggest the word was acquired, but provided evidence the word meaning was correctly identified or inferred and retained until the posttest.

RESULTS

Vocabulary Recall

The participants scored a mean of 1.44 (SD = 1.37, range = 0-5) out 16. In total, of the 1008 cases all participants encountered pseudowords, the meaning of 91 words was correctly comprehended and recalled (9.03%). The working memory score correlated with the vocabulary recall score, $r(41)$ = .35, p = .01.

Words presented in context were more often scored correctly (M = .87, SD = .99) than those that were not (M = .57, SD = .71), and this was a significant difference, $t(62)$ = 2.26, p = 0.01. Relevant words were more frequently recalled (M = .87, SD = 1.05) than irrelevant words (M = .57, SD = .71), which was also significant, $t(62)$ = 2.04, p = 0.02. Table 1 shows the number of words recalled in each condition. The meaning of relevant, cued words was grasped and recalled the most (.57 out 4).

Table 1. The Mean Number of Words Correct (out of 4)

	Relevant	Irrelevant	
Context	.57 (SD = .73)	.30 (SD = .55)	.44
No context	.30 (SD = .54)	.27 (SD = .51)	.29
	.44	.29	

The Relationship with Reading Strategies

Participants looked up 798 words (79.16%) of all pseudowords encountered, and 86 of these words were scored correctly on the meaning recall test (10.78%). Table 2 breaks this down, per participant. Of the 91 words correctly recalled in total, 86 had been looked up

(94.50%). Participants made no regression to review the sentence before checking the word in the dictionary 680 times in total and scored correctly on 69 words (10.15%). Participants made a regression to review the sentence and then used a dictionary 118 times, recalling 17 of them (14.40%). Just concerning relevant words with context cues, this strategy led to incidental recall nearly a quarter of the time (24.13%).

Participants reviewed the sentence after fixating on the pseudoword but then did not use the dictionary 67 times. Five of these words were recalled on the test (7.35%). Concerning just words with context cues, participants made regressions without dictionary use on 38 sentences with context cues, leading to recall on five (13.16%).

Not making a regression and not using a dictionary was a seldom used strategy (8.23% of cases), and this did not lead to the recall of any word meanings.

Table 2. Strategies Used per Participant (out of 16) & Words Recalled

	Regression		No Regression		Not Fixated
	Dictionary	No Dictionary	Dictionary	No Dictionary	
Strategy Used	1.87 SD = 1.96	1.06 SD = 1.75	10.79 SD = 3.73	1.32 SD = 1.77	.95 SD = 2.89
Words Recalled	.27	.08	1.09	0	0
Recall Percentage	14.40%	7.35%	10.5%	0.00%	0.00%

In 441 cases where the pseudoword was in the sentence-middle position, the participants read until the end of the sentence before using a dictionary 31.7% of the time (137). In these cases, they recalled the meaning of the word 8.76% of the time, compared to 7.57% of the cases where they did not use this strategy. In cases, where context cues followed the pseudoword, reading until the end of the sentence and then using the dictionary led to recall in 11.32% of the cases.

Correlation results

The vocabulary scores did not significantly correlate with the fixation duration on the body paragraphs, $r(55) = .08$, $p = .28$, or the pseudowords, $r(55) = .03$, $p = .41$.

The number of regressions after fixating on a pseudoword by participants was not significantly correlated with their vocabulary scores, $r(61) = .19$, $p = .07$, but the results were significant for learners with higher working memory scores (as identified by a K-means cluster analysis), $r(22) = .39$, $p = .03$. In the *relevant, with context* condition, the number of regressions had a significant correlation with the vocabulary test score of these words, $r(61) = .30$, $p = .01$. The time between when a pseudoword was fixated on and the page was exited did not have a significant correlation with the vocabulary scores, $r(55) = -.07$, $p = .3$.

The number of words looked up by participants did not correlate with their vocabulary score, $r(61) = -.15$, $p = .12$. (Significant results were not found among words in any of the four conditions.) However, the 13 participants who looked up the fewest number of words (identified by a K-means cluster analysis) recalled the meaning of 2.15 words ($SD = 1.52$) while other participants recalled the meaning of 1.26 ($SD = 1.27$), a significant difference $t(61) = 2.16$, $p = .03$. Nevertheless, the 28 participants who looked up 15 or all 16 pseudowords also scored higher (1.56), albeit slightly more so, than the overall mean (1.44). Among those with lower working memory scores, there was a positive correlation between look ups and vocabulary recall, $r(14) = .62$, $p = .01$. In contrast, among those with high memory scores, there was a negative correlation, $r(23) = -.38$, $p = .03$.

While there was no significant correlation with the number of look ups among all participants, the fixation duration on dictionary definitions did have a significant correlation, $r(55) = .42$, $p < .0001$. The significant correlation was very strong among the cluster of participants with lower working memory scores, $r(11) = .86$, $p < .0001$, but it was not significant for those with high working memory scores, $r(20) = .21$, $p = .17$.

Just reading on without making a regression or using a dictionary did not correlate with vocabulary test scores, $r(61) = -.01$, $p = .47$.

Not fixating on pseudowords had no correlation with test scores, $r(61) = .11$, $p = .20$. Participants that skipped over one or more pseudowords scored higher ($M = 2.00$, $SD = 1.81$) than the rest of the group, but the results were not significant, $t(61) = 1.59$, $p = .12$.

DISCUSSION

The vocabulary scores corroborated other research showing that few words are recalled when they occur just once in the text, and it found that this is the case even with dictionary use. Words with clear context cues were recalled more, as were words that were relevant to the task.

The Relationship between Strategy Usage and Vocabulary Meaning Recall

Dictionary use

The results suggest that accessing dictionary definitions can improve the chances word meaning will be recalled, both after participants reviewed the context in the text and when they did not. A great majority of the words recalled were after dictionary use. However, overall, participants who looked up more words did not tend to score better on the vocabulary test. In fact, while participants who used the dictionary all the time or nearly all the time scored slightly above average, the cluster of participants that used the dictionary the *least* did much better than average on vocabulary meaning recall.

While the number of words looked up did not have a positive effect (for the participant group as a whole), the fixation duration on dictionary entries did correlate with vocabulary scores. These results differed from Warren and colleagues (2018) but was similar to Lew and colleagues (2018). The findings here support the Involvement Load Hypothesis in that increased mental effort in identifying meaning led to more retention (Hulstijn & Laufer, 2001).

Learner differences seemed to play a role on the use and efficacy of dictionary use. Participants with high working memory tended to use the dictionary less and score better on vocabulary recall, and among these learners, the number of look ups was actually detrimental to their vocabulary scores. In contrast, learners with lower working memory scores recalled the meaning of very few words, but clicking on numerous dictionary links increased the odds that at least one of the words' meaning would be retained. For these learners, the amount time spent fixating on dictionary definitions made a big difference.

Reviewing sentences in the text

The results seem to suggest that making efforts to re-read the context cues does increase the chances of a word will be recalled; words were recalled more frequently after participants used this strategy. Although the strategy was used relatively infrequently, reviewing the sentence and then checking a dictionary was the strategy that led to the highest chances of word meaning recall overall.

There were also five cases where learners recalled the pseudoword meaning after reviewing the sentence, even though they did not use the dictionary. Figure 1 shows one case. The participant had fixated on *thervans*, the pseudoword, and had moved his mouse on

the word in position to click. However, he continued to read to the end of the sentence, which contained a context cue, without clicking the dictionary link. He made a regression to re-fixate on the target word, and then moved the mouse to click to proceed to move to the next page. He recalled the word meaning on the vocabulary test.

Figure 1. Eye movements from one participant at two times. The darker circle, the more recent the fixation. The circle without an outline surrounding the mouse pointer indicates a click.

Nevertheless, overall, the number of regressions made after fixating on a pseudoword did not significantly correlate with the post-reading vocabulary scores. This suggests that making regressions did not help in many cases, which is not surprising since half the words had no context cues. For words that were relevant and had context cues, making more regressions did slightly correlate with vocabulary recall.

Moreover, working memory was a factor; only participants with higher working memory scores benefited from making frequent regressions. This suggests that readers without very strong working memories are unlikely to be able to work out the meaning of a novel word from context while task-based reading and recall it, at least if the word occurs only once.

Reading on or skipping over words

No word meanings were recalled correctly in cases where participants just read without making regressions after fixating on a pseudoword or using the dictionary. Unsurprisingly, this suggests that incidental vocabulary acquisition is very unlikely after fluent reading when the word occurs just once.

Needless to say, not fixating on a word did not lead to those words being recalled. However, it was possible that skipping over some words could have reduced cognitive load, making it possible to better acquire words that were fixated on. Nevertheless, significant results were not found here.

Implications

As L2 learners and educators need to consider reading performance along with incidental vocabulary acquisition when considering the ideal vocabulary coping strategies for reading, the results here will be discussed along with the results of the original study (Prichard & Atkins, 2021), which focused on task performance.

Making regressions to review the context after fixating on novel task-relevant words, led to better task performance (Prichard & Atkins, 2021), and here it led to higher vocab scores, but only for words with context cues. Overall, this supports the idea that readers should be encouraged to examine the context, when relevant, rather than simply clicking the dictionary.

Both studies showed the limitations of frequent dictionary use, especially when the dictionary entry was examined quickly. First, while readers with lower working memory did recall word meaning more from frequent dictionary look ups, very few words were recalled. Second, frequent dictionary use hindered task performance, which was the participants' main reading goal (Prichard & Atkins, 2021).

The current study showed that viewing dictionary definitions longer was beneficial for vocab recall, and the original study (Prichard & Atkins, 2021) showed that fixating longer at the dictionary entries for task-relevant words was also beneficial for task performance. In cases where no context cues were in the text, looking up words provided the only chances that meaning would be identified and recalled in the current study, but whether context cues were present was not a factor on the efficacy of dictionary use for task performance.

Overall, the results of these two studies suggest that educators concerned with both developing reading proficiency and vocabulary acquisition should encourage learners to look up words only when necessary and to check the definition entry closely.

Limitations and Implications for Further Research

The results shown here may be relevant only to the specific factors involved -- where learners had 96% coverage, where target words only appeared once, and where clear context cues were available for half the words. Moreover, the efficacy of looking up words may be different with a dictionary that is more effortful and time consuming to use. Further research is needed with other texts and dictionary type.

Moreover, there were several methods limitations that should be addressed in follow-up research. First, the study only focused on the recall of word meaning. Form, syntax, grammatical functions, and other aspects of word knowledge were not evaluated (Webb, 2007). In addition, the original study was primarily examining the effect of vocabulary strategies on comprehension, and a delayed posttest was not deemed necessary. However, since immediate recall does not mean the word is acquired, future studies should involve delayed tests.

CONCLUSION

While many studies have looked at incidental vocabulary acquisition, this study was unique in that it considered the effect of various vocabulary coping strategies. Eye tracking and navigation tracking was used to identify whether and how much: target words were fixated on, contexts were read and reviewed, and dictionaries were accessed.

Overall, the findings showed that reviewing the context can help in identifying and recalling word meaning, as can looking up words in the dictionary. Together with the main study, which focused on reading performance (Prichard & Atkins, 2021), the data suggest that L2 educators may be better off encouraging learners to carefully consider the context in the text, use the dictionary when necessary, and view dictionary entries carefully. However, the issue is very complicated and depends on the context the word was used in and the working memory of the readers. Further research is called for, including examining the efficacy of the vocabulary coping strategies given various text variables and dictionary types.

ACKNOWLEDGEMENT

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