

*Second language (L2) incidental vocabulary learning:  
The effect of types of post-reading vocabulary tasks  
and spacing intervals<sup>1</sup>*

Aiping Zhao

Shandong University, China

<https://orcid.org/0000-0002-6085-0774>

[aipingzhao@sdu.edu.cn](mailto:aipingzhao@sdu.edu.cn)

Ying Guo

University of Cincinnati, USA

<https://orcid.org/0000-0001-8960-1977>

[guoy3@ucmail.uc.edu](mailto:guoy3@ucmail.uc.edu)

Abstract

This study examined the effect of types of post-reading vocabulary tasks and spacing intervals on L2 incidental vocabulary learning. This study adopted a 2\*2 between-subjects factorial design, the two factors being types of post-reading vocabulary tasks (matching vs. fill-in-blanks) and spacing intervals between reading and post-reading vocabulary tasks (short vs. long). The participants were 90 Chinese-speaking L2 English learners in a comprehensive university in China. They read two texts and were then given an unannounced immediate vocabulary test. Depending on which experimental group they were in, they did the post-reading vocabulary tasks either right after the immediate vocabulary test or one week later. The retention test was given to participants five weeks after the completion of post-reading vocabulary tasks. The ANCOVA results showed L2 vocabulary retention (both receptive and productive) was associated with types of post-reading vocabulary tasks and initial L2 incidental vocabulary acquisition through reading, but not spacing intervals.

*Keywords:* incidental learning; vocabulary retention; L2 reading; task type; spacing intervals

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## 1. Introduction

Many studies have shown that L2 learners can acquire vocabulary incidentally through reading (Hulstijn, Hollander, & Greidanus, 1996; Laufer & Rozovski-Roitblat, 2015; Peters, Hulstijn, Sercu, & Lutjeharms, 2009). That is, learners pick up L2 vocabulary as a “by-product” of reading as they read texts for non-lexical learning purposes such as comprehension, fun, and information. Reading provides the ideal natural context for a learner to process and acquire the richer sense of L2 words such as spelling, meaning, grammatical characteristics, collocation, and colligation (Fan, 2003; Kweon & Kim, 2008). However, despite many advantages of acquiring L2 words incidentally through reading, low acquisition rate and even lower retention rate have remained as its main drawback (e.g., Read, 2004; Rott, 1999; Waring & Takaki, 2003).

L2 incidental vocabulary acquisition through reading usually refers to the immediate vocabulary gain after L2 reading and L2 incidental vocabulary retention refers to the incorporation of words incidentally acquired through L2 reading into one’s long-term memory and available for later retrieval (Min, 2008; Rott, 1999). Laufer and Rozovski-Roitblat (2015) concluded that six to twenty encounters with unknown words in reading were needed for learners to retain some kind of word knowledge. Waring and Takaki (2003) found that only 6% of unknown words met 15-18 times in reading can be remembered on a meaning-recall test three months later. In natural reading conditions, the chance to meet an unknown word many times is rare. Therefore, as a pedagogical effort to facilitate the retention of incidentally acquired vocabulary through reading, enhancement techniques (e.g., post-reading vocabulary tasks) have been utilized (Dupuy & Krashen, 1993; Hulstijn et al., 1996; Laufer & Rozovski-Roitblat, 2015).

Most literature indicates that reading plus post-reading vocabulary tasks is more effective than reading only or reading with dictionaries or glosses in boosting L2 vocabulary retention (Laufer & Rozovski-Roitblat, 2011, 2015; Min, 2008; Peters et al., 2009; Zimmerman, 1997). However, researchers have not come to an agreement as to which post-reading vocabulary tasks were more effective in boosting L2 incidental vocabulary learning (Huang, 2004; Lu, 2013; Rassaei, 2017). More research needs to be done in order to provide empirical evidence for the effectiveness of different post-reading vocabulary tasks in the L2 vocabulary retention (Folse, 2006; Min, 2008).

To enhance L2 incidental vocabulary learning with post-reading vocabulary tasks, another aspect that is of pedagogical concern is spacing intervals (i.e., the intervals at which to carry out the vocabulary tasks after reading). Both L2 acquisition studies and experimental psychology studies have documented a spacing effect. That is, studying information across two or more separated

practice sessions produces better retention results than spending the same amount of time in a single practice session (Carpenter, Cepeda, Rohrer, Kang, & Pashler, 2012; Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006; Schuetze, 2015). However, very few studies have examined the effect of spacing intervals on L2 incidental vocabulary learning and mixed results were obtained (Elgort & Warren, 2014; Webb & Chang, 2015). To address these critical gaps, this study aims to examine the effect of two important factors discussed above, types of post-reading vocabulary tasks (matching and fill-in-blanks) and spacing intervals between reading and post-reading vocabulary tasks (short and long), on the retention of L2 receptive and productive vocabulary knowledge incidentally acquired through reading. In this study, L2 receptive knowledge connotes L2 learners' ability to provide correct meaning of a target word. L2 productive knowledge reflects the L2 learners' ability to use the target word in a sentence that is semantically and grammatically appropriate (Min, 2008).

## 2. Literature review

### 2.1. Post-reading vocabulary tasks and L2 incidental vocabulary learning

Post-reading vocabulary tasks are vocabulary tasks (e.g., fill-in-blanks, matching, rearranging word order, sentence writing) presented after reading materials as vocabulary learning enhancement techniques (Laufer & Rozovski-Roitblat, 2015; Min, 2008). Post-reading vocabulary tasks not only provide learners with the opportunity to process the form-meaning connection they forged during reading to consolidate the information but also draw their attention to some unknown words they ignored in reading and prompt them to continue to explore them (Peters et al., 2009; Wesche & Paribakht, 2000).

Researchers have explained the effectiveness of vocabulary tasks mainly through two related theories, depth of processing and involvement load hypothesis (Laufer & Hulstijn, 2001; Paribakht & Wesche, 1996). Paribakht and Wesche (1996) proposed that vocabulary tasks represent a hierarchy of mental processing activity: selective attention (e.g., bolding the unknown words), recognition (e.g., matching), manipulation (e.g., changing grammatical category), interpretation (e.g., multiple choice cloze exercises), and production (e.g., open cloze exercises). Different vocabulary tasks engage learners in different mental processing activities and thus boost different aspects of vocabulary knowledge (e.g., form, semantic feature, grammatical feature, collocation; Paribakht & Wesche, 1996; Wesche & Paribakht, 2000). For instance, according to Wesche and Paribakht (2000), matching engages the mental activity of recognition and requires learners to associate the target word form with one of its meanings and thus facilitates mainly the building of form-meaning connections. The task of fill-in-blanks mainly involves the mental activity of interpretation

and requires learners to analyze the relationship of the target words and other words in the given context and therefore facilitates the acquisition of both semantic and syntactic features of words and their collocations.

Vocabulary tasks that require deep level of processing of new words and elaboration of different aspects of words on the learners' part are usually effective in boosting L2 vocabulary retention ( Craik & Lockhart, 1972; Hulstijn et al., 1996; Wesche & Paribakht, 2000). However, there has been a lack of definite criteria of how to measure depth of processing (Laufer & Hulstijn, 2001). With an aim to operationalize the notions of depth of processing (Craik & Lockhart, 1972), Laufer and Hulstijn (2001) proposed the involvement load hypothesis, suggesting that different tasks incur different levels of involvement load and the more involvement load a task incurs the more vocabulary acquisition it yields. They conceptualized three components of the task-induced involvement: need, search, and evaluation, among which need is motivational and search and evaluation are cognitive. They used involvement index to measure the involvement load, 0 indicating the absence of an involvement component, 1 the moderate presence of a component, and 2 the strong presence of a component. For instance, if learners are asked to do a fill-in-blanks task without being provided with glosses, the task has an involvement load of 3 (moderate need + search + moderate evaluation).

Studies comparing the effect of different post-reading vocabulary tasks have yielded mixed results (Candry, Elgort, Deconinck, & Eyckmans, 2017; Elgort, Candry, Eyckmans, Boutorwick, & Brysbaert, 2018; Huang, 2004; Lu, 2013; Rassaeei, 2017). In Huang (2004), the Chinese EFL learners first read a passage and then did one of the three post-reading vocabulary tasks: multiple-choice comprehension questions, fill-in-blanks, and sentence writing. Students in the fill-in-blanks and sentence writing groups did significantly better than those in the multiple-choice comprehension questions group in the immediate posttest. In the retention test one week later, the difference between the fill-in-blanks group and multiple-choice comprehension questions group disappeared. Sentence writing was more effective than both fill-in-blanks and multiple-choice comprehension questions in facilitating L2 vocabulary retention. By contrast, Lu (2013) found that a triple fill-in-blanks activity (where students were asked to do three separate sets of fill-in-blanks exercise) was more effective than a single fill-in-blanks activity, a fill-in-blanks activity of summary (where students were asked to fill in the blanks in a text summary prepared by the researcher), and summary writing (where students were asked to use the target words in writing a text summary) in boosting L2 incidental vocabulary acquisition. However, the differences in effectiveness among the four tasks disappeared in the retention test two weeks later.

Elgort et al. (2018) found that reading plus word-writing task was more effective than reading plus meaning-deriving task in boosting the acquisition of

form and meaning of unknown words among Chinese and Dutch learners of English. They maintained that word-writing drew learners' attention to word form and thus added encoding of form to the encoding of meaning incurred by reading sentences. Word-writing led to more precise orthographic representations, which in turn facilitated the development of phonological representations, form-meaning mapping, and an overall improvement of lexical knowledge. By contrast, the meaning-deriving task represented the encoding of meaning already in place, and therefore was less effective than word-writing task.

Rassaei (2017) compared three forms of post-reading writing tasks: writing a passage to make predictions about what is to occur in the text (incorporating the target words), generating questions from the text and answering them (using the target words in the answers), and writing a summary about the text (including the target words in the summary). In the cued-response production posttest, the predicting group and the questioning and answering group outperformed the summarizing group. In the delayed posttest two weeks later, predicting was found to be the most effective, followed by questioning and answering, and then summarizing in boosting L2 vocabulary retention. Rassaei explained that the predicting task required evaluating new words in a new, context while the other two tasks required evaluating new words in a familiar context. Therefore, predicting involved stronger evaluation and triggered greater task involvement than the other two tasks, leading to better vocabulary retention. To sum up, previous research has yielded mixed results regarding the effectiveness of post-reading vocabulary tasks and they mainly focused on the vocabulary tasks of fill-in-blanks and reading-based writing (of words and sentences). There is no research on the effectiveness of other types of post-reading vocabulary tasks such as matching.

## 2.2. Spacing intervals and L2 vocabulary retention

Previous research suggests that spacing interval is associated with L2 vocabulary learning (Ellis, 1995; Nakata, 2015; Pyc & Rawson, 2007; Schuetze, 2015). Learners doing L1 or L2 vocabulary practice sessions in longer spacing intervals usually outperformed those in shorter or no spacing intervals in the vocabulary retention tests (Bahrick, Bahrick, Bahrick, & Bahrick, 1993; Carpenter et al., 2012; Cepeda, et al., 2006; Pavlik & Anderson, 2005). In Bahrick (1979), participants practiced Spanish-English paired associates 1 day, 7 days, and 30 days after initial learning and took the retention test 30 days after the final session. Better retention performance was obtained as the spacing intervals between practice sessions increased. Cepeda et al. (2006) reviewed 184 articles in a meta-analysis and found that spaced learning (with some intervals between learning sessions) is more beneficial to verbal information recall than massed learning (without intervals

between learning sessions). The meta-analysis also revealed a joint effect of spacing interval and retention interval (interval between the final session of practice and retention test). That is, the effect of spacing interval is influenced by the retention interval. As the retention interval becomes longer, the optimal spacing interval becomes longer. According to Cepeda et al. (2006), if the retention interval is less than one minute, the spacing interval of less than one minute maximizes retention. If the retention interval is 6 months or longer, the spacing interval should be at least one month to maximize retention.

Multiple theories and models have attempted to explain the effect of spacing intervals on memory retention. The most comprehensive one might be Raaijmakers' (2003) model which takes advantage of several theories including the search for associative (SAM) theory (Raaijmakers, 2003; Raaijmakers & Shiffrin, 1981), contextual fluctuation theory (Glenberg, 1979; Raaijmakers, 2003), and study-phrase retrieval theory (Russo, Mammarella, & Avons, 2002). SAM theory maintains that initial presentation of an item creates a memory trace and additional presentations of the same item do not create a new trace but strengthen the initial trace. The successful retrieval of an item is related to the overlap between the contextual elements of an item stored in the memory trace and the test context (Raaijmakers, 2003). The more overlap there is, the more likely an item can be recalled. According to the contextual fluctuation theory (Glenberg, 1979; Raaijmakers, 2003), contextual elements fluctuate over time and thus the contextual information in each following presentation becomes more dissimilar to the previous presentations. Therefore, as the spacing intervals increase, overlap of contextual information in presentations decreases and more new contextual information is encoded, increasing the chance for the overlap between contextual elements in one's memory trace and contextual cues in the retention test, which leads to successful recall (Raaijmakers, 2003). Raaijmakers' model (2003) also stresses the importance of study-phrase retrieval by acknowledging that study-phrase retrieval is necessary for the new presentation to be added to the memory trace of that item (Russo et al., 2002). When two different items are presented at different spacing intervals, spacing intervals do not affect memory retention as the second of the two different items cannot trigger the retrieval of the first (Pavlik & Anderson, 2005).

Previous spacing effect studies mainly focused on L2 intentional vocabulary learning as learners were usually asked explicitly to memorize word-paired associates. Very few studies have examined the effect of spacing intervals on L2 incidental vocabulary learning and conflicting results were reported (Elgort & Warren, 2014; Webb & Chang, 2015). Elgort and Warren (2014) investigated individual, text, and vocabulary item variables associated with L2 vocabulary learning through reading. Spacing of items occurrence across chapters was examined as one of the vocabulary item variables. In their study, 48 adult learners of English read four chapters of a

non-fiction book totaling 40,000 words within 10 days and received the vocabulary test of 48 pseudo words upon completion of reading. They found that close spacing of target words (usually within a chapter) was more beneficial to L2 incidental vocabulary learning than longer spacing of target words (usually dispersed across chapters). According to Elgrot and Warren (2014), the multiple encounters of a target word in one chapter reinforced the episodic memory of a target word and helped the word to be integrated into the lexical semantic memory of the learners before it decayed. Besides, multiple encounters of an unknown word in one chapter may draw learners' attention to the word and give them the impression that the word was important for comprehension and thus was worth memorizing. In Webb and Chang (2015), 82 secondary school L2 learners of English read 10 graded readers assisted with audio support in a 13-week-long experiment. Students did one post-test and then one delayed post-test 3 months later. The target words appeared in a range of 1 to 9 books. Webb and Chang (2015) found that the spacing of target words was not related to L2 incidental vocabulary learning in both the posttest and delayed posttest. The conflicting results obtained in these two studies might be due to the many confounding variables in natural reading settings such as the frequency of occurrence of target words and different retention intervals. These two studies focused on the spacing of target words in a text and no study has explored if the spacing interval between reading and post-reading vocabulary tasks exerts influence on L2 incidental vocabulary learning.

### 3. The present study

A review of previous literature shows that post-reading vocabulary tasks were important in facilitating L2 incidental vocabulary learning. However, there is no agreement as to which type of post-reading vocabulary tasks was more effective. Most previous studies focus on the effect of fill-in-blanks and reading-based writing on L2 incidental vocabulary learning and leave other commonly used vocabulary tasks such as matching unexplored. There is limited research on the effect of spacing of target words on L2 incidental vocabulary learning, and the effect of spacing intervals between reading and post-reading vocabulary tasks on L2 incidental vocabulary learning was unexamined. This study aims to fill in these gaps by exploring the following specific questions.

1. Is the retention of incidentally acquired L2 receptive vocabulary knowledge related to the types of post-reading vocabulary tasks, and the spacing intervals between reading and the post-reading vocabulary tasks?
2. Is the retention of incidentally acquired L2 productive vocabulary knowledge related to the type of post-reading vocabulary tasks, and the spacing intervals between reading and the post-reading vocabulary tasks?

Based on the involvement load hypothesis (Laufer & Hulstijn, 2001) and recent studies on the effect of word-writing on contextual word learning (Candry et al., 2017; Elgort et al., 2018), we hypothesize that the post-reading task of fill-in-blanks is more effective than matching in facilitating the retention of both receptive and productive vocabulary knowledge as it induces higher level of involvement load and the physical act of writing words in blanked sentences, which tends to result in an overall improvement of vocabulary knowledge including form, meaning, and use. Based on SAM theory (Raaijmakers, 2003) and study-phrases retrieval theory (Russo et al., 2002), which claim that spacing effect is observable only when the second presentation of words can trigger memory trace of initial presentation, we hypothesize that the spacing interval between reading and post-reading tasks might not have an effect on L2 incidental vocabulary retention. This is because the incidental vocabulary acquisition rate from reading is usually low and thus most unknown words learners met in reading do not create initial memory traces. Consequently, the second encountering with these words in post-reading tasks will not trigger memory trace of initial presentation.

## 4. Method

### 4.1. Participants

Participants were 90 Chinese-speaking English L2 learners enrolled in four English classes at a comprehensive university in eastern China. The participants fell into the age range of 18-22 with an average age of 19. All participants were sophomores majoring in English, with an average English learning experience of 8.6 years in school settings. This study adopted a 2\*2 between-subjects factorial design with the two factors being type of post-reading vocabulary tasks (matching vs. fill-in-blanks) and the spacing intervals between reading and post-reading vocabulary tasks (short vs. long). The four classes were randomly assigned to one of the four research conditions: matching + short interval ( $N = 25$ ), matching + long interval ( $N = 27$ ), fill-in-blanks + short interval ( $N = 18$ ), fill-in-blanks + long interval ( $N = 20$ ).

### 4.2. Texts

The two reading texts were used in a previous study by the Authors (Zhao, Guo, Biales, & Olszewski, 2016). One text was an excerpt from the essay *All Un-Along in the City* (hereafter *City*) and the other from an essay *Can We Know the Universe – Reflections on a Grain of Salt* (hereafter *Universe*). The difficulty level of the two texts for participants in the present study was assessed in two steps. First, the word frequency of the texts was analyzed with the *Range and Frequency*



*Programs* (Heatley, Nation, & Coxhead, 2002). The *City* text has 960 tokens in length and 94.48 % of the tokens fall within the 5000 most frequent words in the British National Corpus. The *Universe* text has 851 tokens in length with 94.95% of the tokens falling within the 5000 most frequent words in the British National Corpus. Second, to estimate the difficulty level of the texts to participants in the present study, we followed the procedures used in Swanborn and de Glopper (2002). Three instructors teaching the same proficiency level of students as those in our study were asked to mark the words in the two texts that they deemed to be unknown to the majority students in their class. A word marked at least by two instructors was considered to be potential unknown words. Through this procedure, 25 words in the *City* text and 27 words in the *Universe* text were identified as potential unknown words. Based on this number, the known words ratio in the *City* text was estimated to be 97.40% and the *Universe* text 96.83%. These known words ratio was appropriate for L2 reading comprehension and vocabulary learning (Hu & Nation, 2000; Waring & Takaki, 2003). The potential unknown words were chosen for the purpose of calculating the estimated known words ratio and they might not be unknown to all participants. The procedure of selecting target words and measuring participants' pre-knowledge of target words was described in the following two sections. Glosses of unknown words were provided at the bottom of each page to facilitate incidental vocabulary acquisition (Hulstijn et al., 1996). In this study, gloss presents vocabulary information including part of speech, English explanation, and Chinese translation.

#### 4.3. Target words

Twenty target words were selected from the two texts according to the following procedures. First, we identified 14 words in the *City* text and 15 words in the *Universe* text as candidate target words as they were marked as unknown by all three instructors mentioned in the previous section. This procedure was done to ensure that the candidate target words were unknown to the majority of participants in our study. Second, out of these candidate target words, we selected 10 from each text ensuring that the target words were highly specified words carrying content meaning. Third, we carried out a pilot study with the target words among 26 students at the same proficiency level as participants in this study. Four students reported knowing one word and one reported knowing two words. The rest of the 21 students reported knowing none of the target words. As not one word was recognized by more than one student, all target words were included in the present study.

#### 4.4. Post-reading vocabulary tasks

Two types of post-reading vocabulary tasks, matching and fill-in-blanks, were used in this study. Matching and fill-in-blanks were chosen as the post-reading vocabulary tasks in this study because 1) these two tasks are widely used as post-reading vocabulary tasks in L2 classrooms and studies (Liu, 2007; Min, 2008; Peters et al., 2009) and 2) they incur different levels of involvement load and are supposed to have different effects on vocabulary retention but their effects have seldom been empirically compared. When doing the post-reading vocabulary tasks, students were not provided with glosses but were allowed to use dictionaries. Therefore, in terms of involvement load, both matching and fill-in-blanks induced “moderate need” as the need is imposed by vocabulary tasks and not self-imposed by the learners. Both matching and fill-in-blanks induced “search” as learners need to consult dictionaries to find the meaning of unknown words. Matching induced no evaluation as this task mainly requires students to recognize the meanings of words and does not require the evaluation of word meanings against a certain context. By contrast, fill-in-blanks requires the evaluation of word meanings in order to complete a given sentence and thus induced moderate evaluation. Therefore, the involvement load index of matching was 2 (moderate need + search - evaluation) and that of fill-in-blanks was 3 (moderate need + search + moderate evaluation). More specifically, in the matching tasks, 10 target words from each text were listed in the left column and the English definitions were randomly listed in the right column. Participants were required to match each target word in the left column with its definition in the right column (see Appendix A). In the fill-in-blanks tasks, 10 target words from each text were put in the word banks. Ten sentences with one blank in each sentence were given below each word bank. Participants were required to fill in each blank with an appropriate target word from the word bank.

#### 4.5. Vocabulary test

A vocabulary test of the 20 target words was administered to participants immediately after they finished reading the two passages and also five weeks after they had completed the post-reading vocabulary tasks. A Chinese version of modified Vocabulary Knowledge Scale (VKS; Min, 2008) was used in this study. In this test, a target word was followed by four choices: I. I don't remember having seen this word before; II. I have seen this word, but I don't know what it means; III. I know this word, it means\_\_\_; IV. I can use this word in a sentence. If participants chose III, they were asked to provide either the English definition or the Chinese translation of the word. If they chose IV, they were asked to write a sentence

using the target word and also complete choice III. These four choices correspond to four categories of word knowledge respectively: unknown words, partially known words, receptive knowledge of words, and productive knowledge of words. For the purpose of this study, scores of receptive knowledge and productive knowledge of words were used. In the vocabulary test, the target words were listed in a random order to control for order effect.

The scoring rubric used in Min (2008) was adopted in this study. In scoring choice III, one point was assigned to a correct English definition or Chinese equivalent. No point was assigned if the English definition or Chinese equivalent was wrong. In scoring choice IV, one point was assigned if the word was used semantically and grammatically correct. No point was assigned if the sentence the participants wrote showed a misunderstanding of the target word meaning or if the word was used ungrammatically. One researcher of this study and one colleague of hers rated both choices III and IV on the vocabulary tests. The inter-rater reliability for choice III on both the immediate vocabulary test and delayed vocabulary test was 0.99, and that of choice IV on the two tests was both 0.98. On the immediate vocabulary test, participants were also required to report which words they already knew before reading the texts. Nine participants reported knowing one, three participants knowing two, and the rest of the participants reported knowing none before reading the texts. All the 12 participants who reported knowing one or two words were able to provide correct English definition or Chinese equivalent for the word(s) in choice III and make a semantically and grammatically correct sentence using the word(s) in choice IV. Initial receptive and productive word knowledge acquisition scores were calculated by subtracting the pre-knowledge receptive and productive vocabulary scores from the receptive and productive scores on the immediate vocabulary test. Incidental receptive and productive word knowledge retention scores were calculated by subtracting the pre-knowledge receptive and productive vocabulary score from the receptive scores and productive scores on the delayed vocabulary tests.

#### 4.6. Procedure

The study was carried out in regular class meetings. Participants in all the four research conditions were given the two texts to read. They were instructed to try to understand the texts and then answer some comprehension questions after reading. The instruction was given to the participants with a purpose to direct their focal attention to text comprehension rather than vocabulary learning, constituting one major condition for incidental vocabulary learning. After participants had finished reading, the researchers collected the texts and the participants were given an unannounced immediate vocabulary test. Besides this immediate

vocabulary test, the participants were given a delayed post-test five weeks after they had finished the post-reading vocabulary tasks. We gave participants the immediate vocabulary test right after reading instead of after post-reading vocabulary tasks for two reasons. First, initial vocabulary acquisition from reading was included as the covariate in this study because previous studies have shown that it is associated with L2 incidental vocabulary retention (Min, 2008). Therefore, for the purpose of this study we need to know learners' initial vocabulary acquisition from reading without the enhancement of vocabulary tasks. Second, this study focused on the effect of post-reading vocabulary tasks on long-term retention of L2 vocabulary instead of immediate acquisition. It was not necessary to give participants another vocabulary test after the vocabulary tasks since tests have learning effect and might affect subsequent test results (Webb & Chang, 2015).

After the immediate vocabulary test, participants in the "short interval" condition did the post-reading vocabulary tasks (either matching or fill-in-blanks). Participants in the "long interval" condition did the post-reading vocabulary tasks one week later also at a regular class meeting. In both conditions, students were allowed to use dictionaries when doing the tasks. All students could finish the vocabulary tasks in the time frame of 20 minutes. The time for task completion was controlled in this study as time was found to be a factor influencing task effectiveness (Keating, 2008). Participants did the delayed vocabulary test five weeks after they had completed the post-reading vocabulary tasks. The ratio of the long spacing interval (1 week) and retention interval (5 weeks) in our study was 20%, falling into the optimal ratio of 10% to 20% as suggested by Cepeda, Vul, Rohrer, Wixted and Pashler (2008) for best retention result.

## 5. Results

*Research question 1:* Is the retention of incidentally acquired L2 receptive vocabulary knowledge related to the types of post-reading vocabulary tasks, and the spacing intervals between reading and the post-reading vocabulary tasks?

A two-way analysis of covariance (ANCOVA) was conducted with retention of L2 receptive vocabulary knowledge as the dependent variable, types of tasks and spacing intervals as independent variables, and the initial L2 receptive vocabulary knowledge acquisition from reading as the covariate. Types of tasks have two levels: matching and fill-in-blanks. Spacing intervals also have two levels: short and long. The assumptions for ANCOVA were met. In particular, the homogeneity of the regression effect was evident for the covariate and the covariate was linearly related to the dependent variable. Results showed that the retention of L2 receptive vocabulary knowledge was significantly related to types of post-reading vocabulary tasks after controlling for the initial L2 receptive vocabulary

knowledge incidentally acquired through reading,  $F(1, 85) = 6.55, p < .05, \eta^2_p = 0.07$  (see Table 1). Participants in the fill-in-blanks group ( $M = 4.03, SD = 3.32$ , see Table 2) had significantly more retention of L2 receptive vocabulary knowledge than those in the matching group ( $M = 2.62, SD = 2.62$ ). Results also showed a significant relationship between retention of L2 receptive vocabulary knowledge and the initial L2 receptive vocabulary knowledge incidentally acquired through reading,  $F(1, 85) = 25.96, p < .05, \eta^2_p = 0.23$ . The more initial L2 receptive vocabulary knowledge participants incidentally acquired through reading, the more L2 receptive vocabulary knowledge they could retain ( $\beta = .48, p < .05$ ). Neither the spacing interval nor the interaction between spacing interval and type of tasks effect was significant. In general, participants acquired some L2 receptive vocabulary knowledge through reading (an average of 2.97 out of 20) and retained a little bit more five weeks later (an average of 3.23 out of 20) as enhanced by the post-reading vocabulary tasks.

Table 1 ANCOVA results for receptive vocabulary knowledge retention by type of tasks, spacing intervals, and initial receptive vocabulary knowledge acquisition (IRVKA) through reading

Source	SS	df	MS	F	$\eta^2_p$
IRVKA	172.19	1	172.19	25.96*	.23
Type	43.45	1	43.45	6.55*	.07
Spacing	1.65	1	1.65	0.25	.00
Type * Spacing	19.53	1	19.53	2.94	.03
Error	563.74	85	6.63		

Note.  $R^2 = .28, adj. R^2 = .25$ , adjustments based on IRVKA mean = 2.97. IRVKA regression coefficient  $\beta = 0.48^*$ . \*  $p < .05$

Table 2 Descriptive statistics of receptive vocabulary knowledge retention by type of tasks and spacing intervals

Type	massed				spaced				Spacing total			
	M	adj. M	SD	n	M	adj. M	SD	n	M	adj. M	SD	n
Matching	2.16	2.01	2.06	25	3.33	3.23	2.99	27	2.77	2.62	2.62	52
Fill-in-blanks	4.28	4.37	3.44	18	3.45	3.70	3.25	20	3.84	4.03	3.32	38
Total	3.05	3.19	2.89	43	3.38	3.46	3.07	47				

Note. Grand mean = 3.23 ( $SD = 2.97$ ),  $N = 90$ . Adjusted mean based upon initial receptive vocabulary knowledge acquisition = 2.97.

**Research question 2:** Is the retention of incidentally acquired L2 productive vocabulary knowledge related to the type of post-reading vocabulary tasks, and the spacing intervals between reading and the post-reading vocabulary tasks?

Another two-way analysis of covariance (ANCOVA) was conducted with retention of L2 productive vocabulary knowledge as the dependent variable, types

of tasks and spacing intervals as independent variables, and the initial L2 productive vocabulary knowledge acquisition from reading as the covariate. Again, both types of tasks and spacing intervals have two levels. The assumptions for ANCOVA were met. Results showed that the retention of L2 productive vocabulary knowledge was significantly related to types of vocabulary tasks after controlling for the initial L2 productive vocabulary knowledge incidentally acquired through reading,  $F(1, 85) = 8.87, p < .05, \eta^2_p = 0.09$  (see Table 3). Participants in the fill-in-blanks group ( $M = 1.18, SD = 2.17$ , see Table 4) had significantly more retention of L2 productive vocabulary knowledge than those in the matching group ( $M = 0.34, SD = 0.88$ ). Results also showed a significant relationship between retention of L2 productive vocabulary knowledge and the initial L2 productive vocabulary knowledge incidentally acquired through reading,  $F(1, 85) = 35.96, p < .05, \eta^2_p = 0.30$ . The more initial L2 productive vocabulary knowledge participants incidentally acquired through reading, the more L2 productive vocabulary knowledge they could retain ( $\beta = 0.58, p < .05$ ) five weeks later. Neither the spacing interval nor the interaction between type of tasks and the spacing interval effect was significant. In general, participants acquired a small amount of productive knowledge through reading (an average of 0.81 out of 20) and the retention after five weeks was even lower (an average of 0.70 out of 20), although they did post-reading vocabulary tasks as enhancement.

Table 3 ANCOVA results for productive vocabulary knowledge retention by type of tasks, spacing intervals, and initial productive vocabulary knowledge acquisition (IPVKA) through reading

Source	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	$\eta^2_p$
IPVKA	63.31	1	63.31	35.96*	.30
Type	15.62	1	15.62	8.87*	.09
Spacing	1.25	1	1.25	0.71	.00
Type * Spacing	1.69	1	1.69	0.96	.01
Error	149.66	85	1.76		

Note.  $R^2 = .35$ , *adj. R*<sup>2</sup> = .32, adjustments based on IPVKA mean = 0.81. IPVKA regression coefficient  $\beta = .58^*$ . \*  $p < .05$

Table 4 Descriptive statistics of productive vocabulary knowledge retention by type of tasks and spacing intervals

Type	massed				spaced				Spacing total			
	<i>M</i>	<i>adj. M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>adj. M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>adj. M</i>	<i>SD</i>	<i>n</i>
Matching	0.28	0.78	0.61	25	0.41	0.60	1.48	27	0.35	0.34	0.88	52
Fill-in-blank	1.28	1.20	1.87	18	1.10	1.16	2.45	20	1.18	1.18	2.17	38
Total	0.70	0.64	1.37	43	0.70	0.88	1.80	47				

Note. Grand mean = 0.70 ( $SD = 1.60$ ),  $N = 90$ . Adjusted mean based upon initial productive vocabulary knowledge acquisition = 0.81.

## 6. Discussion

Our findings indicate that retention of both L2 receptive and productive vocabulary knowledge is associated with types of post-reading vocabulary tasks. More specifically, learners in the fill-in-blanks group retained more L2 receptive and productive vocabulary knowledge than those in the matching group. In our study, fill-in-blanks with a higher involvement load of 3 (moderate need + search + moderate evaluation) was more effective than matching with a lower involvement load of 2 (moderate need + search - evaluation) in facilitating vocabulary retention. Thus, this finding lends support to the involvement load hypothesis that tasks with higher involvement load yield better vocabulary learning results (Hulstijn & Laufer, 2001). The higher involvement of fill-in-blanks demands learners to evaluate the target words more elaborately, leading to better retention.

The reason why fill-in-blanks can better boost receptive and productive vocabulary knowledge than matching can also be explained by the different mental processing activities and physical activities required by the two tasks (Candry et al., 2017; Elgort et al., 2018; Paribakht & Wesche, 1996; Wesche & Paribakht, 2000). According to Paribakht and Wesche (1996), fill-in-blanks involves higher level mental processing activity of interpretation, while matching involves the lower level mental processing activity of recognition. Besides, fill-in-blanks requires learners to write down the words in the blank and the physical act of word-writing is likely to facilitate the acquisition of high-quality lexical knowledge as it draws learners' attention to both word form and meaning (Candry et al., 2017; Elgort et al., 2018). In doing the fill-in-blanks task, learners need to not only recognize the meaning of an unknown word but also analyze it against its neighboring words in sentences (e.g. grammatical constraints and collocation) and then write it down. Therefore, fill-in-blanks draws learners' attention to not only the semantic features but also the orthographic features, syntactic features, and collocation that are vital to learner's later production of target words in sentences, explaining why fill-in-blanks can better boost the retention of both L2 receptive and productive vocabulary knowledge than matching.

Our findings showed that spacing intervals did not have an effect on the retention of incidentally acquired L2 receptive or productive vocabulary knowledge. Participants who did the vocabulary tasks immediately after reading had similar vocabulary retention as those who did the vocabulary tasks one week later after the reading. This finding conforms to Webb and Chang's (2015) study which found no effect of spacing of target words on L2 incidental vocabulary learning but contradicts with Elgort and Warren's (2014) study which found that shorter spacing of target words led to better retention result. The inconsistent results between Elgort and Warren (2014) and our study might be due to the different retention intervals

in these two studies. In Elgrot and Warren (2014), the retention interval was rather short, that is, students took the retention test upon the completion of reading materials. By contrast, in our study, the retention test was conducted five weeks after the completion of post-reading vocabulary tasks. The effect of spacing intervals was affected by retention intervals (Cepeda et al., 2006).

This finding is also in contradiction to previous L2 intentional vocabulary learning research which demonstrated that longer spacing intervals usually led to better L2 vocabulary retention (Cepeda et al., 2006; Nakata, 2015; Pyc & Rawson, 2007). The different results might be attributed to the difference in the initial vocabulary acquisition rate in these studies and our study. In previous L2 intentional vocabulary retention studies, learners are usually required to focus on vocabulary and remember all the words in the initial presentation stage. In our study, the initial vocabulary acquisition from reading was small due to its incidental nature. Two theoretical frameworks might explain why this difference can lead to the non-effect of spacing intervals on L2 incidental vocabulary retention in this study.

First, as described before, the SAM theory claims that only remembered words create a memory trace (Raaijmakers, 2003). Based on this theory, what created memory traces in L2 incidental vocabulary acquisition was the limited number of incidentally learned words through reading. The rest of unknown words encountered in reading were neglected and thus did not create memory traces. Second, the post-reading vocabulary tasks added more contextual information to the memory traces of only the words learners remembered in the initial presentation during reading. According to the contextual fluctuation theory, this group of words might be influenced by spacing intervals (Raaijmakers, 2003). However, the low initial acquisition rate of L2 receptive and productive knowledge (an average of 2.97 and 0.81 out of 20 respectively) through reading in our study indicates that most unknown words were not remembered and thus memory traces were not created for them in initial presentation during reading. Hence, when learners met these words again in the post-reading vocabulary tasks, these words would not trigger the memory of their first presentation and thus the spacing interval would not affect their retention (Pavlik & Anderson, 2005; Russo et al., 2002).

It is also worth noting that the initial vocabulary acquisition from reading made the largest contribution to the retention of both receptive and productive vocabulary knowledge in this study. That is, the more words learners acquire from reading, the more they can retain five weeks later. The initial acquisition of words from reading is especially important as post-reading vocabulary tasks can only facilitate learning if the words were learned during reading (Pavlik & Anderson, 2005). In other words, whether or not learners can retain a newly encountered word largely depends on if they can initially learn it from reading.



## 7. Pedagogical implications

Our findings suggest some implications for L2 vocabulary learning and teaching. First, learners and teachers should be aware that it is viable to retain L2 vocabulary knowledge especially the L2 receptive vocabulary knowledge through reading with the aid of post-reading vocabulary tasks. After encountering unknown words in reading and doing post-reading vocabulary tasks, learners were able to retain more than 16% (an average of 3.23 out of 20) of the L2 receptive vocabulary knowledge five weeks after the post-reading vocabulary tasks. Second, we suggest that teachers take types of tasks into account when they choose and design post-reading vocabulary tasks. Vocabulary tasks that require higher level of involvement load and word-writing such as fill-in-blanks can better improve both receptive and productive vocabulary retention than those that require lower level of involvement load and no word-writing such as matching. Third, teachers can adopt various means to help boost initial L2 vocabulary acquisition through reading as it is strongly associated with L2 incidental vocabulary retention. For instance, when preparing reading materials, teachers can have the unknown words bolded and/or provide glosses (Jacobs, Dufon, & Hong, 1994). Teachers can also encourage learners to be strategic learners by skillfully mastering a set of individualized strategies that facilitate the inferencing of meaning and committing words to memory (Nassaji, 2003). Fourth, as spacing interval is not found to be associated with retention in this study, it is suggested that learners can do the post-reading vocabulary tasks either immediately after reading or a few days later at their convenience. However, it should be cautioned that this suggestion might not be suitable if learners have more than two practice sessions since our finding is based on two practice sessions (reading with target words glossed and post-reading vocabulary tasks).

## 8. Conclusion

To conclude, our study corroborates previous findings that L2 incidental vocabulary retention can be boosted if learners had the opportunity to process the words again (e.g., through post-reading vocabulary tasks) after encountering them in reading (Peters et al., 2009). It provides evidence that some post-reading vocabulary tasks, especially those that require higher level of involvement load and more elaborate evaluation of words (e.g., fill-in-blanks), are more effective than others in facilitating L2 incidental vocabulary retention. According to our knowledge, this study is the first to examine the effect of spacing intervals between reading and post-reading vocabulary tasks on L2 incidental vocabulary learning. The result that no effect of spacing interval on L2 incidental vocabulary

retention was observed can be largely attributed to the low initial vocabulary acquisition rate through reading and explained by Raaijmakers' (2003) SAM theory, contextual fluctuation theory and study-phase retrieval theory.

Several important limitations of the present study warrant mentioning. First, due to logistic reasons, we only had two practice sessions (reading with target words glossed and post-reading vocabulary tasks). Though the effect of spacing intervals can be examined through two practice sessions (Carpenter et al., 2012), previous research shows that the effect of spacing intervals on retention is greater when the number of practice sessions increases (Pavlik & Anderson, 2005). Therefore, one of the possible reasons why we did not observe the effect of spacing intervals on L2 incidental vocabulary learning might be the limited practice sessions we had. Second, we focused on two task types, matching and fill-in-blanks, and left other vocabulary tasks (e.g., rearranging word order) unexamined. To have a better picture of the effectiveness of different post-reading vocabulary tasks, researchers need to include more task types in future study. Third, although participants in the matching and fill-in-blanks groups were given the same time limit, we did not record the exact time they used in finishing the two tasks. An accurate record of time on task is suggested for future studies on the effectiveness of vocabulary tasks.

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Appendix A

Samples of Post-reading Vocabulary Tasks

I. Match each item in Column A with phrases and explanations in Column B.

A	B
1. fluff___	a. that never fail, always doing what is supposed to do
2. subdued___	b. small pieces of wool, cotton, soft animal fur
3. ferment___	c. of the practice of helping the poor and those in need
4. hallucinogen___	d. sexual intercourse between two persons commonly regarded as too closely related to marry
5. intrepid___	e. (of a person) usually quiet, and possibly unhappy
6. sinew___	f. to experience a chemical change because of the action of yeast or bacteria, often changing sugar to alcohol
7. infallible___	g. a drug, such as LSD, that affects people's minds and makes them see and hear things that are not really there
8. incest___	h. a solid or hollow figure with twelve equal square sides
9. philanthropic___	i. very brave, not afraid of danger or difficulties
10. dodecahedron___	j. a strong band of tissue in the body that joins a muscle to a bone

II. Fill in each blank with appropriate word in the following word bank.

infallible, fluff, philanthropic, incest, dodecahedron,  
subdued, hallucinogen, ferment, sinew, intrepid

1. There are small bits of \_\_\_\_\_ floating in the air.
2. For her \_\_\_\_\_ conduct nursing the wounded during the war, Florence Nightingale was honored by Queen Victoria.
3. \_\_\_\_\_ is a taboo in almost every culture.
4. We all make mistakes as nobody is \_\_\_\_\_.
5. The billionaire was renowned far and wide for his \_\_\_\_\_ generosity.
6. The church bonds us together just as the body is knit with \_\_\_\_\_ and skin.
7. Scientists in the US are now suggesting that universe could be finite and shaped like a \_\_\_\_\_.
8. We \_\_\_\_\_ the grapes for a very long time to achieve high alcohol content.
9. She became very \_\_\_\_\_ after she knew that her boyfriend was not able to come back for her birthday
10. It is extremely dangerous to drive under the influence of \_\_\_\_\_.