



# The effect of extensive reading and paired-associate learning on long-term vocabulary retention: An event-related potential study

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## HIGHLIGHTS

- This study reports the first ERP findings in the extensive reading literature.
- Extensive reading led to significant long-term vocabulary retention.
- Paired-associate learning was effective only in short-term vocabulary retention.
- These findings are supported by the N400 component of event-related potentials.
- These findings are also supported by behavioral measures.

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## ABSTRACT

We investigated the relative efficacy of extensive reading (ER) and paired-associate learning (PAL) in the ability of second language (L2) learners to retain new vocabulary words. To that end, we combined behavioral measures (i.e., vocabulary tests) and an event-related potential (ERP) investigation with a focus on the N400 ERP component to track short- and long-term vocabulary retention as a consequence of the two different approaches. Behavioral results indicated that both ER and PAL led to substantial short-term retention of the target words. In contrast, on a long-term basis, ER was more effective than PAL to a considerable degree as indicated by a large-size effect ( $d = 1.35$ ). Evidence from the N400 effects ( $d = 1.70$ ) observed in the parietal electrode group (P3, Pz, P4) provided further support for the superior effects of ER over PAL on long-term vocabulary retention. The converging evidence challenges the assumptions of some L2 researchers and makes a significant contribution to the literature of vocabulary acquisition, because it provides the first ERP evidence that ER is more conducive to long-term vocabulary retention than PAL.

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## 1. Introduction

There is a growing consensus among second language (L2) researchers that sufficient lexical knowledge is a critical component of L2 proficiency [7,10,22]. Coady and Huckin [3] claim that L2 learners should acquire a substantial vocabulary in order to attain competencies in language skills such as listening, speaking, reading, and writing. In a related vein, learners who do not have a large repertoire of vocabulary knowledge typically avoid reading and may struggle throughout their schooling [8].

A vast body of research has established that extensive reading (ER) is a highly effective means of vocabulary development, especially for first language (L1) learners [5,17,18]. As an illustration,

Cunningham and Stanovich [5] found that the amount of time spent on reading is one of the most potent predictors of vocabulary size for learners in grades 4, 5, and 6. Nagy et al. [18] concluded that an average amount of reading probably accounts for a third of the vocabulary growth of a child, and that regular and extensive reading is a strong predictor of substantial and permanent vocabulary development.

Several L2 researchers also report evidence in support of ER [12,20]. For instance, Krashen [12] finds that vocabulary learning through meaning-focused reading significantly contributes to vocabulary building. Similarly, Nation and Wang [20] and Waring and Takaki [25] also find that the reading of graded readers is effective in vocabulary development.

Counter-arguments, however, were also put forward by other L2 researchers [2,9,14–16,19,23]. Several researchers reported that ER is not an efficient means of L2 vocabulary acquisition. For instance, in Zahar's [27] study, grade seven L2 learners were asked to read a story entitled *Golden Fleece* and respond to a vocabulary test. The results indicated no significant effect of story reading on word

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acquisition. Moreover, many L2 researchers found that decontextualized vocabulary learning methods such as mnemonic strategies and repeated rehearsals are far more effective than learning words from context [15,16,23]. For instance, Qian [23] compared the effects of decontextualized word lists and contextualized vocabulary on vocabulary acquisition. The researcher found that learners in a decontextualized condition learned more words than did their counterparts in a contextualized condition. More recently, Lindstromberg and Boers [16] showed that a mnemonic strategy using alliteration resulted in significant lexical gain. Laufer and Girsai [15] found that contrastive semantic analysis (e.g., comparing the degree of overlap between L1 and L2 words) yields a better outcome than meaning-oriented tasks for the short- and long-term learning of new words. In sum, the trends in L2 vocabulary acquisition have gravitated toward explicit attention to target words in a decontextualized manner and through frequent rehearsals [9,14].

Despite the work of these researchers to address the impact of the ER and decontextualized vocabulary learning, three questions still remain unanswered. First, little knowledge is shed on the relative efficacy of ER and decontextualized vocabulary learning in light of short- and long-term vocabulary retention. Second, although paired-associate learning (PAL), that is, learning new foreign words with their translations or synonyms, is one of the most popular methods in decontextualized vocabulary learning, no previous studies have compared the effects of PAL with that of ER on vocabulary acquisition. Research has consistently shown that PAL is an effective means of acquiring new words [19,20,26]. For instance, Webb [26] compared relative efficiency of receptive and productive PALs with Japanese L2 learners. The results showed that productive PAL was more effective than receptive PAL in the acquisition of new words. In fact, PAL represents the most prevailing strategy for the participants in this study (Korean students who learn English as a foreign language), whereas ER represents the least-favored vocabulary learning approach for the same participants. Finally, online evidence using event-related potentials (ERPs) has never been demonstrated previously to determine the effects of ER and PAL. To better understand the effects of ER and PAL, it is imperative to identify electrophysiological responses underlying the potentially different effects of ER and PAL.

## 2. Present study

Two aspects set this study apart from previous studies. First, unlike previous studies, the present study directly compared the relative efficacy of ER and PAL in the same study. Second, we measured online vocabulary processes by recording electrophysiological responses. Specifically, we performed a priming experiment (i.e., prime–target paradigm) with a specific focus on the N400 component of ERPs. The N400 is a negative brain potential which peaks approximately 400 ms after the onset of a stimulus (hence the term N400). It is correlated with how well a word (i.e., target) semantically fits in with previous stimuli (i.e., prime), such as a word, a sentence, discourse, or image. The poorer the fit, the larger the N400 effect; the better the fit, the more reduced the N400 effect [13]. In other words, when a word is congruent with its preceding stimuli (e.g., shark – fish), the N400 effects are reduced. Conversely, when a word is unrelated with its previous stimuli (e.g., shark – sky), the N400 effects are increased.

To illustrate, a recent study by Schmidt-Kassow et al. [24] focused on the N400 component to determine the effects of exercising on vocabulary learning. The findings indicated that participants who were physically active during vocabulary learning performed better in vocabulary tests and also showed a larger N400 effect over central and right hemispheric electrode sites in reaction to the prime–target mismatch condition (e.g., apple–dog). In our study,

the presence of an N400 effect elicited by prime–target violations would reveal the relative effectiveness of ER and PAL in vocabulary learning. For instance, if ER were more effective than PAL, ER participants would show a larger N400 effect than PAL for mismatched prime–target pairs.

## 3. Methods

### 3.1. Participants and design

In the current study, twenty-six adult native Korean speakers volunteered to take part in a 9-week experiment (twelve subjects were excluded from data analysis because they did not complete all the tasks). We offered small gifts in appreciation of their participation instead of monetary compensation. In order to control for confounding variables, the participants were screened in terms of handedness, age, gender, language proficiency, and knowledge of target words. For instance, all participants were right-handed with no history of neurological or psychiatric disorders, and their eyesight was normal or corrected to normal vision. They all agreed to avoid any intentional English-related activities throughout the duration of experiment. The participants were pseudo-randomly assigned to one of two exposure conditions, ER and PAL. The two groups were matched for age (mean age = 25) and language proficiency (low intermediate level).

This study employed a between-subjects pre-test, immediate post-test, and delayed post-test design. Specifically, this study is composed of an exposure period (i.e., ER and PAL for five weeks, respectively) and three test phases: (i) pre-exposure phase, (ii) immediate post-exposure phase, and (iii) delayed post-exposure phase (four weeks after immediate post-exposure phase). At each phase, participants performed a vocabulary test and responded to prime–target stimuli while their EEG activities were recorded. The vocabulary test and stimuli were identical across the three test phases.

### 3.2. Procedures

The 9-week experiment was conducted in the following way. First, we measured participant knowledge of 80 target words (plus 70 dummy words) before exposure (i.e., ER and PAL) in order to reduce the variability due to the two groups' knowledge of target English words. The result showed that the two groups did not differ significantly ( $t = .658, p = .523$ ), indicating that the two groups were homogenous in the knowledge of the target words.

Second, ER and PAL groups were exposed to the same target words according to their respective condition. Specifically, the ER group participants were asked to read a book per week (1 book  $\times$  5 weeks = 5 books). The selected books were five graded readers at level three from Penguin Young Readers (three fiction and two nonfiction books) – *Sherlock Homes and other stories*, *Sense and Sensibility*, *Titanic*, *A Young King and other stories*, and *The British Life*. Participants were allowed to select the order to read the books. They were also allowed to use a dictionary when they encountered unknown words. However, they were not told which words they would be tested on after five weeks of reading. To ensure that they read all of the books, we examined their comprehension of the main ideas after each reading.

In the PAL group, participants were asked to memorize thirty word pairs in two languages each week (such as statue – 동상). All told, they were requested to learn 150 words by heart. As with ER group participants, the PAL group participants were also not told which words they would be tested on. In order to ensure that they memorized thirty target words per week, we followed up on their learning.

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