

Reconstructing Lexical Networks of Japanese EFL Learners: An Application of Technique Feature Analysis to Already-Known Words

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Abstract

This study employed Technique Feature Analysis (TFA) criteria to analyze the characteristics of tasks effective for reconstructing Japanese EFL learners' lexical networks. We focused on the deepening and expansion of knowledge of already-known words. Twenty words were selected from an essay, and participants (73 Japanese university students) evaluated the perceived relationships among these words (Test 1). One week later, they read the essay and completed one of three tasks. Participants in the MCQ group answered ten multiple-choice questions regarding the meanings of the target words. The FIB group filled in ten blanks in the essay using target words provided with their meanings and usage examples. The Comp group completed ten sentences unrelated to the essay with the target words. TFA points assigned to the tasks were calculated as 5 for MCQ, 7 for FIB, and 8 for Comp. After completing the task, participants took the same word-relationship test (Test 2). Finally, four weeks after Test 2, participants completed Test 3. The results showed that word-relationship scores increased from Test 1 to Test 2 and decreased from Test 2 to Test 3 in all groups. No significant effects of group (i.e., task type) were found. The results were also analyzed and visualized using Gephi, a data visualization platform, revealing qualitative features of individual changes in lexical networks. The present findings did not correspond to the learning effects predicted by TFA, suggesting that more appropriate tasks and/or evaluation criteria are necessary for applying the TFA framework to the learning of already-known words.

Keywords: Japanese learners of English, lexical network, extensive reading, already-known words, Technique Feature Analysis

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Introduction

Considerable debate has been devoted to the extent to which extensive reading contributes to vocabulary acquisition. Consistent with his Input Hypothesis, Krashen (1989) argued that extensive reading alone can lead to substantial vocabulary acquisition, and numerous studies have since attempted to examine this claim using a variety of methodological approaches. While most of this research has focused on the acquisition of new vocabulary, Horst, et al. (1998) suggested that, although extensive reading may play only a limited role in vocabulary acquisition for beginning second language learners, it nevertheless has the potential to deepen learners' knowledge of already-known words and to strengthen the lexical network by establishing new connections among these words. Pigada and Schmitt (2006) further argued that the effects of extensive reading on vocabulary learning should be evaluated from multiple perspectives, including form, meaning, and use, as represented in Nation's (2001) framework of nine aspects of word knowledge. Likewise, Waring and Takaki (2003) maintained that authors of graded readers should pay less attention to the introduction of new vocabulary alone and instead provide learners with richer collocational information for words they have already learned.

The conceptual model of the mental lexicon as a network structure has been widely accepted (e.g., Aitchison, 1994). This model is inspired by the fact that the human brain itself consists of interconnected neural networks, in which lexical items (nodes) metaphorically correspond to neurons and the links among them correspond to synaptic connections. An increase in vocabulary size is thus conceptualized as an increase in the number of nodes, whereas the enrichment of knowledge about an individual word is viewed as the creation of additional links. This network metaphor provides a compelling representation of how lexical knowledge may be organized in the human mind. Accordingly, a number of pedagogical studies have attempted to facilitate vocabulary learning by presenting semantically related groups of words. However, in most cases, these semantic relationships are theoretically determined rather than empirically derived from evidence showing how actual language users associate words in their mental lexicon (Wilks & Meara, 2002).

The Levels of Processing theory proposed by Craik and Lockhart (1972) argues that the depth of cognitive processing directly influences memory performance. Building upon this framework, Laufer and Hulstijn (2001) proposed the Involvement Load Hypothesis (ILH), which provides an index for predicting the effectiveness of incidental vocabulary learning induced by tasks accompanying extensive reading. Although numerous studies have examined the validity of the ILH, the vast majority have focused primarily on the retention of newly learned words. Motivated by this line of research, we conducted research which aimed to investigate how extensive reading, together with task-induced cognitive involvement as conceptualized in the ILH, promotes the deepening and broadening of lexical network structures centered on already-known words among Japanese learners of English.

This series of studies yielded two major findings (Aotani & Takahashi, 2022, 2023, 2025). First, tasks that are effective in promoting the retention of newly learned vocabulary are not necessarily effective in deepening or broadening the lexical network structures of already-known words. Second, the three components of psychological involvement proposed by the ILH—*need*, *search*, and *evaluation*—are insufficient for identifying the characteristics of tasks that facilitate lexical network restructuring. These findings suggest the necessity of adopting an alternative analytical framework for task evaluation.

Alongside the ILH, Technique Feature Analysis (TFA), proposed by Nation and Webb (2011), provides another influential framework for analyzing the characteristics of vocabulary learning tasks. Several studies have compared the validity of the ILH and the TFA, identifying both their strengths and limitations (Gohar et al., 2018; Hu & Nassaji, 2016; Qin, 2023). However, these studies have also focused exclusively on the acquisition and retention of newly learned vocabulary. The present study aimed to apply the TFA framework to examine the task characteristics that promote the restructuring of lexical networks, which could not be adequately explained by the ILH.

Methods

Participants

Seventy-three Japanese university students (45 males and 28 females, mean age: 20.5 years old) participated in the experiment as paid volunteers.

Materials

An essay about a student project to create a shared public space on campus (word types 247, word tokens 446) was generated by ChatGPT as the reading material. Twenty target words (5 verbs; *draw, run, take, hold, make*, 5 adjectives; *empty, bright, sharp, great, public*, 10 nouns; *idea, place, change, mind, line, money, eye, pain, difference, attention*) were selected from the essay.

Procedure

The experiment consisted of three parts.

Part I

All participants performed a lexical relation test (LRT; Test 1). They were instructed to judge the degree of perceived relationship between two target words (100 pairs resulted through the combination of 10 verbs/adjectives and 10 nouns) on a 7-point scale (1: “weakly-related” – 7: “strongly-related”).

Part II

One week later, participants were divided into three groups according to their scores in Test 1 that were equalized in group means. They read the essay and performed assigned task designed on the basis of the Technique Feature Analysis (TFA) as follows.

Participants in MCQ (multiple-choice question) group answered ten multiple-choice questions about the meaning of the target words (two-word phrase; e.g., *great idea*).

Participants in FIB (fill-in-the blank) group filled in ten blanks in the essay using target words (5 verbs and 5 adjectives) provided with their meanings and usage examples.

Participants in Comp (composition) group completed ten sentences unrelated to the essay with the target words (5 verbs and 5 adjectives) highlighted in the essay.

Table 1*TFA Points Assigned to the Task of Each Group*

TFA check items		MCQ	FIB	Comp
Motivation				
1	Is there a clear vocabulary learning goal?	0	1	1
2	Does the activity motivate learning?	1	1	0
3	Do the learners select the words?	0	0	0
Noticing (Attention)				
4	Does the activity focus attention on the target words?	1	1	1
5	Does the activity raise awareness of new vocabulary learning?	0	1	1
6	Does the activity involve negotiation?	0	0	0
Retrieval				
7	Does the activity involve retrieval of the word?	1	0	0
8	Is it productive retrieval?	0	0	0
9	Is it recall?	0	0	0
10	Are there multiple retrievals of each word?	0	0	0
11	Is there spacing between retrievals?	0	0	0
Generation (Creative Use)				
12	Does the activity involve generative use?	1	1	1
13	Is it productive?	0	0	1
14	Is there a marked change that involves the use of other words?	0	0	1
Retention				
15	Does the activity ensure successful linking of form and meaning?	0	1	1
16	Does the activity involve instantiation?	0	0	0
17	Does the activity involve imaging?	0	0	0
18	Does the activity avoid interference?	1	1	1
Total Score		5	7	8

TFA points assigned to the tasks were calculated as 5 for MCQ, 7 for FIB, and 8 for Comp according to the theory and presented examples in the TFA literatures (see Table 1). After finishing the task, all participants answered the same LRT (Test 2) as in Part I.

Part III

Four weeks after Test 2, all participants answered the same LRT (Test 3) as in Parts I and II.

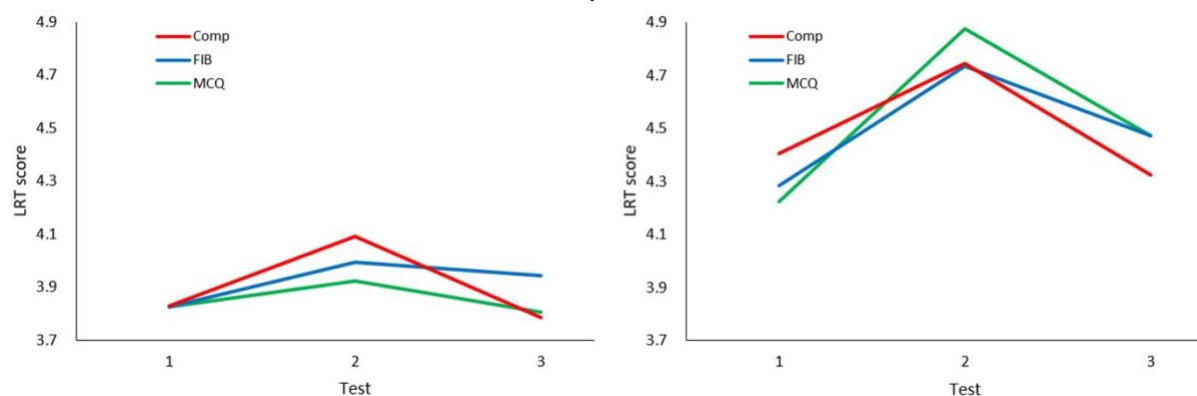
Results

Quantitative Analysis

Ratings for the LRT were averaged for each participant and in each test. Figure 1(a) shows mean LRT score in three tests in each group. Two-way (Group $\times$ Test) Analysis of Variance (ANOVA) revealed a significant main effect of the Test factor ($F_{(2,140)} = 4.884, p = .009, \eta^2 = .065$). Post-hoc analysis showed that the scores were significantly higher in Test 2 than in Test 1 and Test 3. The main effect of the Group factor and the interaction of factors were not significant.

Figure 1

Mean LRT Score in Three Tests in Each Group



Note. (a) For all data (100 pairs)

(b) For collocated words data (16 pairs)

Next, an additional analysis was conducted on the data for the 16 out of 100 word-pairs that collocated in the essay. Figure 1(b) shows the results. Two-way (Group $\times$ Test) ANOVA revealed a significant main effect of the Test factor ($F_{(2,140)} = 18.629$, $p < .001$, $\eta^2 = .210$). Post-hoc analysis showed that the scores were significantly higher in Test 2 than in Test 1 and Test 3. The main effect of the Group factor and the interaction of factors were not significant.

Qualitative Analysis (Gephi)

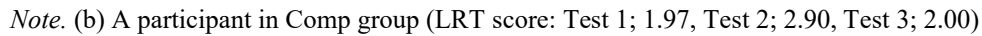
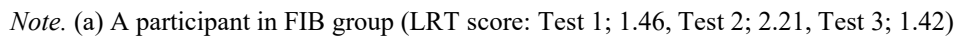
The individual LRT data was analyzed and visualized by Gephi (Bastian et al., 2009), a data-visualization platform, to show how participant's lexical network among target words changed through three tests. Figure 2 shows samples of two participants.

Discussion

As shown in Figure 1(a), learning effect was clearly demonstrated immediately after the task (Test 2) in all groups. However, the effect did not last for four weeks (Test 3). The same pattern was found in the authors' previous research (Aotani & Takahashi, 2025). Because participants spent only a short time, about 10 minutes in most cases, working on the tasks in these studies, it is likely that long-term learning effects were difficult to achieve.

On the other hand, the effects of tasks with different TFA points, which were our main focus of interest, were not observed. According to a TFA point of the task in each group, we predicted that the highest learning effects would be obtained in Comp group, followed by FIB group and MCQ group. Although visual inspection of Figure 1 suggested a trend in this direction, this trend was not statistically significant. There are several possible explanations for this result. First, as mentioned above, the relatively short amount of time spent on the task suggests that participants' engagement with the task may have been insufficient. Second, the differences among the TFA points in three groups (5, 7, and 8 points) may have been too small to result in different learning effects. Finally, TFA is a framework designed for new word learning and may not be directly applicable to facilitating the comprehension of already-known words.

Samples of a Visualized Lexical Network Among Target Words Generated by Gephi



An analysis of the individual data using Gephi yielded some interesting findings. The two samples shown in Figure 2 indicate that the network among the target words became denser from Test 1 to Test 2. In addition, Figure 2(a) suggests that basic verbs such as *make*, *take*, and *hold* developed stronger connections with many nouns in Test 2. Figure 2(b) suggests that the lexical networks of central words in the essay, such as *public* and *place*, became denser in Test 2. However, in both cases, these effects were hardly observed in Test 3. These considerations clarify the importance of investigating individual data as well as group data.

The present study aimed to identify task characteristics that promote the deepening and expansion of learners' lexical networks for already-known words through extensive reading, using the TFA framework. However, the results of the experiment did not support the

predictions of the TFA, even though the tasks used were conventional ones that have been widely employed in previous research on the retention of newly learned words. Future studies should design new tasks that are tailored to the characteristics of Japanese learners of English and that enable the incidental development of lexical networks through extensive reading. In addition, the TFA framework itself, which was designed basically for the retention of newly learned word, should be reconsidered, and further research should explore the development of a new framework that accounts for the deepening and expansion of lexical networks of already-known words.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The authors declare that ChatGPT was used in proofreading and refining the language used in the manuscript, in addition to creating the reading material. The usage was limited to correcting grammatical and spelling errors and rephrasing statements for accuracy and clarity. The author further declares that, apart from ChatGPT, no other AI or AI-assisted technologies have been used to generate content in writing the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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