Breadth and depth of vocabulary knowledge for L2 learners and native speakers of Japanese

Yukie Horiba

（Kanda University of International Studies）

Abstract

The breadth of vocabulary knowledge (i.e., form-meaning connections) and depth of vocabulary knowledge (i.e., word associations) were assessed for Chinese and Korean learners of Japanese as a second language (SL) (the CSL group and the KSL group, respectively), Chinese and Thai learners of Japanese as a foreign language (the CFL group and the TFL group, respectively), and native speakers (the NS group) of Japanese. Both second language (L2) learners and natives performed better with higher frequency words than with lower frequency words and on nouns than on verbs and adjectives/adverbs for form-meaning connections. Furthermore, L2 learners performed the best on nouns for both paradigmatic and syntagmatic associations, suggesting that they rely more on nouns when processing word co-occurrences and collocations. In contrast, native speakers performed the best on nouns for paradigmatic associations and on adjectives/adverbs for syntagmatic associations, suggesting that their word association networks reflect functional language use and concept representations. In addition, word class knowledge differed among L2 learners for both form-meaning connections and word associations, suggesting the possible influence of first language (L1) background and learning environment.

Keywords: vocabulary breadth, vocabulary depth, Japanese as a second language, L1 background, learning environment

1．Introduction

Vocabulary knowledge is critical in language communication, including reading. For most learners of a non-native language (L2), the learning of the form-meaning connections of words may be a priority. Significant progress

has been made in research on vocabulary in L2 learning, highlighting the multi-dimensionality of vocabulary knowledge (Nation, 2001; Nation & Webb, 2011; Read, 2000; Schmitt, 2000) and its relation to reading comprehension (Qian, 2002). However, the majority of previous studies focused on English as a second language (ESL) or foreign language (EFL), and there is little empirical evidence available for a less commonly taught/researched language such as Japanese. Thus, the purpose of the present study is two-fold. First, this study aims to help accumulate empirical evidence for receptive vocabulary knowledge in Japanese and, subsequently, test the generalizability of some of the previous research findings. Second, it explores the characteristics of vocabulary knowledge development for L2 learners with different first language (L1) backgrounds and learning environments. Furthermore, the data obtained from native speakers are used to explore both universal and unique features of vocabulary knowledge development among different speaker groups.

２．Background
2.1 Breadth and depth of vocabulary knowledge

  Vocabulary knowledge is multidimensional and consists of different components. The multidimensionality of vocabulary knowledge is often captured by the distinction between breadth and depth (Henriksen, 1999; Nation, 1990, 2001; Read, 2000, 2004; Wesche & Paribakht, 1996). Breadth or size refers to the quantitative dimension of vocabulary knowledge (i.e., how many different words are known). Historically, this dimension has received considerable attention from researchers and practitioners alike. Vocabulary size generally correlates with reading comprehension and is used as a proxy for the level of language proficiency (Bernhardt & Kamil, 1995; Laufer, 1997; Nation, 2001; Qian, 2002; Stæhr, 2008). The most widely used test in English as a measure of vocabulary size is possibly Nation's Vocabulary Levels Test (1990, 2001). The test consists of words from different bands or levels of frequency (2,000-, 3,000-, 5,000-, and 10,000-word level and the University

Word list) and the test taker matches the target word and its definition in the multiple-choice format.

The other dimension, depth, is related to the quality of knowledge. There are various definitions of and approaches to the depth of vocabulary knowledge (Henriksen, 2008; Meara, 1996, 2009; Nation, 2001; Read, 2004; Wesche & Paribakht, 1996). A particularly useful approach defines depth as how words are connected to one another in the network knowledge called mental lexicon (Aitchison, 1994; Haastrup & Henriksen, 2000; Meara, 2009). Studies using this framework typically employ a word association task in which the test taker produces a word that first comes up to mind for the target word (cue). Responses are analyzed and grouped into categories such as paradigmatic (e.g., table-furniture), syntagmatic (e.g., erase-data), and other (e.g., phonological: donkey-monkey; situational: hospital-doctor) to infer the associative patterns of meaning connections between words in the mental lexicon. Read's Word Associates Test (1993, 1998) is a well-known measure of receptive knowledge of word associations in English. In this test, the test taker selects words (or associates) that have a paradigmatic relation (i.e., synonym or similar in meaning with one being more general than the other) or a syntagmatic relation (i.e., often occur together in a phase or collocate) with the target word. Receptive word association test scores tend to correlate with language proficiency and reading comprehension (Greidanus, Beks, & Wakely, 2005; Horiba, 2012; Qian, 2002). This suggests that the two dimensions of vocabulary knowledge, breadth and depth, are interrelated and may not be completely separable.

2.2 L2 vocabulary development and the native norms

The development of vocabulary knowledge is influenced by various factors or variables that may interact with each other. Word frequency is an important item-related variable in L1 and L2 learning. Words that occur more frequently are recognized and learned faster than words that occur less frequently; words already acquired are used to process sentences and texts containing

new words, simultaneously strengthening the existing word knowledge (Ellis, 2012). In his review of previous studies that examined both vocabulary size and depth, Schmitt (2014) concluded that for higher frequency words and for learners with smaller vocabulary sizes, there is often little difference between the two dimensions, whereas for lower frequency words and for learners with larger vocabulary sizes, the development of depth often lags behind the growth of size.

Word class or category is another variable affecting vocabulary development. It is generally assumed that nouns are easier to learn because they are more concrete and imageable and have clear boundaries, whereas verbs and adjectives are more difficult to learn because they are ambiguous and relative and have fuzzy boundaries (Ellis & Beaton, 1993; Imai, Haryu, Okada, Li, & Shigematsu, 2006). However, the boundaries between words in the same semantic domain may differ in different languages. Saji and Imai (2013), examining how L1 and Korean and Japanese L2 learners of Chinese use "carrying/holding" verbs, showed that L1 children frequently use one or two broad-covering verbs in the initial stage and gradually learn 13 verbs, whereas L2 adults are influenced by their lexical knowledge of L1 with Korean learners using five verbs and Japanese learners using seven verbs.

One of the most salient similarities between the words of two different languages is cognates. Cognates are words whose form and meaning considerably overlap across two or more languages, irrespective of whether the similarity results from language typology or borrowing processes. Although cognates are generally easier to learn than non-cognates (Jarvis & Pavlenko, 2008), the cognate effect may be influenced by variables such as word class and false cognates, that is, words that are only formally similar but their L1 and L2 meanings differ (Bultena, Dijkstra, & van Hell, 2014; Jarvis & Pavlenko, 2008; Otwinowska & Szewczyk, 2019).

When considering vocabulary depth as network knowledge of word associations, the distinction between paradigmatic and syntagmatic relations is important. Paradigmatic association involves words that have similar

meanings or are categorically related (e.g., hypernym-hyponym); the two words (i.e., the cue and the response) belong to the same word class (e.g., noun-noun, verb-verb). In contrast, syntagmatic association involves words that collocate or co-occur in the same sentence; the two words belong to different word classes (e.g., noun-verb, adjective-noun). L1 children shift in their pattern of responses from syntagmatic to adult-like paradigmatic, while responses of adults reflect a shift back to the syntagmatic (Aitchison, 1994). De Deyne and Storms (2008) investigated word association performances of L1 Dutch adults in a continuous task (i.e., each participant responded with three associations to the cue) and reported interesting findings. First, a paradigmatic to syntagmatic shift occurred among the total number of first, second, and third responses. In addition, adjective and verb cues produced a majority of noun responses (i.e., adjective→noun, verb→noun; syntagmatic associations), whereas noun cues produced noun responses (i.e., noun→noun; paradigmatic associations). Second, network analysis showed that central nodes (words) in the network tended to be high frequency words that were acquired early (i.e., Age of Acquisition), and the hubs (highly connected nodes) were mainly adjectives and nouns, not verbs. Third, regarding the semantic features of responses, taxonomic information (especially superordinate information) was generated more quickly than conceptual information (i.e., entity or situation properties). These findings provide insights into the nature of native speakers' vocabulary knowledge networks and their connection to concept representations.

As for L2 learners, research using a productive word association task showed that more proficient learners tend to produce more paradigmatic responses (Zareva, 2007; Zareva & Wolter, 2012). Furthermore, highly proficient learners reportedly produce more native-like responses (Fitzpatrick, 2012; Schmitt, 1998), though the findings are not consistent (Zareva, Schwanenflugel, & Nikolova, 2005). Other studies showed that paradigmatic responses are more likely to be produced when cue words are nouns (Nissen & Henriksen, 2006). Research using a receptive measure

showed that paradigmatic associations tend to be more accurate than syntagmatic associations for lower-frequency words for both L2 learners and natives (Greidanus et al., 2005; Greidanus & Nienhuis, 2001; Horiba, 2012). However, previous L2 word association research has reported mixed findings, and it is difficult to compare the findings because of the variability in research methodology and theoretical orientation (for a comprehensive review, see Firzpatrick & Thwaites, 2020). Considering the powerful impact of the learner's L1 background and the L1-L2 distance on L2 learning (Koda & Mitsugi, 2007; Odlin, 2003; Schepens, van der Slik, & van Hout, 2016), L2 word association research is warranted that investigates the interaction between word class and association type (i.e., paradigmatic and syntagmatic) for L2 learners with different L1 backgrounds.

The present study involved native Japanese speakers and L2 learners of Japanese with Chinese, Korean, and Thai backgrounds. Japanese is an agglutinative SOV language that uses a case-marking system. The Japanese orthographic system employs a combination of *kanji* (or Chinese characters) and two sets of *kana* syllabaries (*hiragana* and *katakana*). Chinese is an isolating SVO language that lacks any form of inflectional morphology and employs a logographic written system of Chinese characters. Korean also is an agglutinative SOV language that uses a case-marking system, and its orthography employs alphabets called Hangul. Thai is an isolating SVO language, and its orthography employs the abugida system of writing (or alphasyllabaries). Considering the learner's L1 background or the L1-L2 distance, some predictions can be made regarding the development of receptive vocabulary knowledge in Japanese. Chinese learners who can benefit from their *kanji/kanjigo* knowledge would have an advantage in learning and recognizing vocabulary items written in *kanji*. Koreans learners, who can benefit from syntactic knowledge when processing sentences, may have some advantage in recognizing words in sentences with similar structure. Thai learners whose L1 is linguistically distant from Japanese at all levels would require more effort to process and learn the language, compared with their

Chinese and Korean counterparts. We also examined native Japanese speakers because 1) there is no empirical evidence available about the native norms in Japanese, and 2) the use of native norms can potentially help scrutinize the nature of L2 vocabulary knowledge.

3．Research questions

The research questions prepared for the study are as follows:

Q1: Does the breadth of vocabulary knowledge develop similarly for L2 learners with different L1 backgrounds and in different learning environments?

Q2: Does the depth of vocabulary knowledge develop similarly for L2 learners with different L1 backgrounds and in different learning environments?

Q3: How does the breadth and depth of vocabulary knowledge for L2 learners differ from native speaker norms?

4．Methods

4.1 Participants

Four groups of L2 learners, including 70 Chinese-speaking and 60 Korean-speaking Japanese as a second language learners (CSL group and KSL group, respectively) and 60 Chinese-speaking and 94 Thai-speaking Japanese as a foreign language learners (CFL group and TFL group, respectively), and a group of native speakers of Japanese ($N = 150$, the NS group) participated in the study. Table 1 presents the demographic information of the non-native participants.

For L2 learners in Japan, a total of 156 international students were recruited who were mostly exchange students enrolled in JSL programs at various universities in the Kanto and Kyushu regions of Japan. Their L1 backgrounds were diverse: Chinese (73), Korean (62), Other (21; English (6), Mongolian/ Portuguese/ Thai (3), Vietnamese (2), Indonesian/Spanish/French/Dutch (1)). As is the case with typical enrollment in Japanese language programs in Japan, the number of participants who were not Chinese or Korean was small;

Table 1

Demographic information of non-native participants

	SL in Japan		FL in China	FL in Thailand
Number of individuals	70	60	60	94
L1 background	Chinese	Korean	Chinese	Thai
Gender	54（77%）	49（82%）	22（37%）	80（85%）
Female	16（23%）	11（18%）	38（63%）	14（15%）
Male				
Age	22.4（2.4）	22.5（2.4）	20.7（1.4）	20.4（1.0）
M (SD)				
Grade level in the program				
2nd-year	N/A	N/A	29（48%）	27（29%）
3rd-year			13（22%）	25（27%）
4th-year			18（30%）	42（45%）
Months of Japanese language learning				
M (SD)	40.5（23.4）	40.4（29.2）	26.4（11.1）	44.9（10.0）[a]
Min-Max	11–120	9–144	12–48	30–66+
Months of residence in Japan				
M (SD)	22.0（20.0）	19.5（18.7）		
Min-Max	3–81	3–72	0	0
JLPT passed				
Level 1	39（56%）	36（60%）	4（7%）	0
Level 2	9（13%）	11（18%）	0	2（2%）
Level 3	1（1%）	6（10%）	0	24（26%）
Level 4	0	0	0	30（32%）
None	21（30%）	7（12%）	56（93%）	38（40%）

Note. SL = second language learners; FL = foreign language learners; L1 = first language; JLPT = Japanese language proficiency test.

[a] Participants responded by choosing from 0–2 years, 2–3 years, 3–4 years, 4–5 years, or more than 5 years; 28 individuals chose "more than 5 years."

therefore, they were not considered in this study. The CFL group originally consisted of 67 Chinese students majoring in Japanese (2nd, 3rd, and 4th year levels) at a national technology-oriented university in China. Faculty members in their program were all native Chinese (except for one native Japanese instructor). There were no communities nearby where Japanese was used. Most students (94%) began learning Japanese upon entering the university and were motivated to study the language to pass the highest level of the Japanese Language Proficiency Test (JLPT; Japan Foundation, 2002) before graduation. The TFL group originally consisted of 95 Thai students majoring in Japanese (2nd, 3rd, and 4th year levels) at a national university in Thailand. Faculty members of the Japanese program were all native Thai (except for one native Japanese instructor). There was a Japanese community nearby, where some students visit for their internship program. Many students had earlier exposure to Japanese in high school. The number of Japanese learners in South Asian countries has increased significantly in recent years. According to the survey report on overseas Japanese Language Education 2018 (Japan Foundation, 2020), China (1,004,625) topped the list of students learning Japanese in educational institutions, followed by Korea (531,511) and Thailand (184,962) at third and fifth place, respectively. The NS group consisted of 158 undergraduates (133 females and 25 males; average age = 19.7) majoring in foreign language, communication, and sociology at several universities in Japan. Data from the participants who did not complete all the tasks or follow the task instructions (CSL (3), KSL (2), CFL (7), TFL (1), NS (8)) were discarded.

4.2 Materials

Two vocabulary tests, one each to measure breadth and depth of vocabulary knowledge, and a background questionnaire were used in the study.

Target words and test development. A total of 156 target words were used in the vocabulary tests including 60 nouns, 60 verbs, 24 adjectives, and 12 adverbs. The target words were equally distributed across four levels of

frequency (I–IV; I: highest, IV: lowest). The same target words were used in the two vocabulary tests. The target words in the three high(er) frequency levels (i.e., I, II, and III) were selected from the vocabulary corpus for the 4th/3rd, 2nd, and 1st level of the JLPT (Japan Foundation, 2002), respectively.[1] The target words in the lowest frequency level (i.e., IV) were selected from outside sources in order to assess vocabulary knowledge at the superior or near-native level.[2]

Vocabulary breadth test. This test consisted of 52 items. For each item, six words were listed on the left and three simple "definitions" or descriptions were listed on the right. The test format was adapted from Nation's Vocabulary Levels Test (2001) because it allows learners to respond without processing sentences. The six words for each item were chosen from the same frequency level and word class, but they differed in terms of semantic domain. The "definitions" were written using simple words (i.e., words from the same or higher frequency levels). The words and the definitions were presented in the *a-i-u-e-o* order. All *kanji* characters were presented with *kana* syllabaries to indicate pronunciation. The test taker was asked to match the words on the right with the definitions on the left that best described the words. An example was provided with the task instructions (Appendix A). The items were sequenced gradually from easy to hard. Two versions of the test were created using the same items with the presentation order randomly altered (within the same word class, within the same frequency level). Thirty minutes were allocated to complete the test.

Vocabulary depth test. This test consisted of 156 items. In each item, a target word was presented with six words in the box below. The words in the box were from the same or higher frequency level than the target word. The test format was adapted from Read's Word Associates Test (1993, 1998) because it allows L2 learners to use knowledge of word associations without processing sentences. A recognition task is considered more suitable than a production task to assess L2 learners' vocabulary knowledge as network that is used in reading. Therefore, the test was designed to elicit one

paradigmatically related word and two syntagmatically related words for each target word. The test taker was explicitly told, "One word has meaning similar to the target word. There are two words, each of which is often used together with the target word in a sentence. Make sure to circle only three words." The task instructions were in simple Japanese. The words in the box were presented in the *a-i-u-e-o* order. All *kanji* characters were presented with *kana* syllabaries to indicate pronunciation. Three examples were provided with simple explanations to help them understand the task instructions (Appendix A). The items were sequenced gradually from easy to hard. There were two versions of the test using the same items with a random presentation order (within the same word class, within the same frequency level). Sixty minutes were allocated to complete the test.

Background questionnaire. A background questionnaire was used to obtain basic information such as age, sex, L1 background, length of studying Japanese, length of residency in Japan, JLPT status, and experiences of learning other foreign languages.

4.3 Procedure

Participants took the breadth of vocabulary test first, followed by the background questionnaire. The depth of vocabulary test was administered last as it was cognitively more demanding.

4.4 Analysis

Each participant's responses to the vocabulary tests were scored and then analyzed using JMP 5.0 (from SAS). A three-way analysis of variance (*ANOVA*) was performed to examine the effects of group (a between-subjects variable) and frequency level and word class (within-subject variables) for the breadth test, and association type and word class (within-subjects variables) for the depth test. To further examine the characteristics of vocabulary knowledge for each group, a two-way *ANOVA* was performed. For the depth test scores, the possible effect of language proficiency was statistically controlled using the

scores of breadth test. For post-hoc analyses of pairwise comparisons, Tukey's HSD tests (α = .05) were used.

5．Results

5.1 Breadth of vocabulary: Effects of frequency level and word class

Cronbach's alpha was used to assess the reliability of the breadth test. High internal consistency (overall = .93, frequency level = .69–.89) was found for L2 learners. The internal consistency (overall = .66) was not high for native speakers because of the possible ceiling effect at levels I–III. Table 2 presents the descriptive statistics of the breadth test. Means and standard deviations are shown in Figure 1. The total average score was 94% (SD = 3.4) for the NS group, 78.2% (SD = 6.5) for the CSL group, 73.2% (SD = 9.2) for the CFL group, 67.6% (SD = 14.0) for the KSL group, and 42.0% (SD = 13.2) for the TFL group. Three-way $ANOVA$ for L2 learners revealed significant main effects of frequency (F = 1926.57, p < .0001, η^2 =.36) and word class (F = 80.08, p < .0001, η^2 =.01); however, the main effect of group was not significant (F = 2.21). There were significant effects of interactions of group and frequency (F = 75.37, p < .0001, η^2 =.04), group and word class (F = 2.98, p < .0001, η^2 =.01), and frequency and word class (F = 20.89, p < .0001, η^2 =.01). The effect of group $\times$ frequency $\times$ word class interaction was also significant (F = 11.13, p < .0001, η^2 =.01).

To examine the effect of frequency and word class for each group, two-way $ANOVAs$ were conducted (Table 3). The frequency effect was robust for all L2 groups and the NS group. The effect of word class was also significant, with a small effect size for all L2 groups, but none for the NS group. The effect of frequency-word class interaction was significant for all L2 groups and the NS group.

The results of Tukey's HSD test for the interaction between frequency and word class are shown in Table B1 (Appendix B). The NS group scored similarly across word classes at levels I–III (except for level II), but they did show the noun>verb>adjective/adverb pattern at level IV (i.e., the word class effect).

Table 2
Descriptive statistics of the breadth test scores by frequency level and word class

Group	N	Word class	Frequency level							
			I		II		III		IV	
			M	SD	M	SD	M	SD	M	SD
NS	150	N	99.6	2.0	99.3	2.0	98.7	3.9	88.4	12.0
		V	99.5	1.8	98.8	2.5	96.9	5.2	78.9	11.7
		A	98.5	4.2	91.0	8.1	97.4	6.1	74.8	17.8
Chinese	70	N	99.6	1.6	91.4	9.2	93.3	9.0	68.7	15.7
-SL		V	96.8	4.6	86.1	9.7	80.9	11.5	32.1	14.0
		A	86.0	14.1	79.8	18.5	67.8	18.2	40.6	16.8
Korean	60	N	98.8	4.0	85.3	20.0	74.3	24.9	43.2	22.7
-SL		V	95.3	9.0	75.4	17.1	61.6	22.7	24.6	14.7
		A	85.9	14.3	78.1	21.7	54.8	25.6	21.7	19.9
Chinese	60	N	96.9	5.6	86.8	9.1	84.4	16.1	63.6	16.1
-FL		V	93.8	5.3	79.1	13.0	80.9	15.6	30.4	15.8
		A	83.0	16.2	67.0	19.5	60.6	23.5	32.0	15.5
Thai	94	N	92.4	13.5	51.6	27.4	30.0	22.2	19.5	20.5
-FL		V	81.2	23.7	41.3	24.4	27.3	19.6	13.8	16.3
		A	67.7	32,6	24.5	29.4	25.2	25.7	8.5	16.9

Note. NS = native speakers; SL = second language learners; FL = foreign language learners; I = most frequent; IV = least frequent; N = noun; V = verb; A = adjective/adverb.

Figure 1
Breadth of vocabulary as a function of frequency level and word class
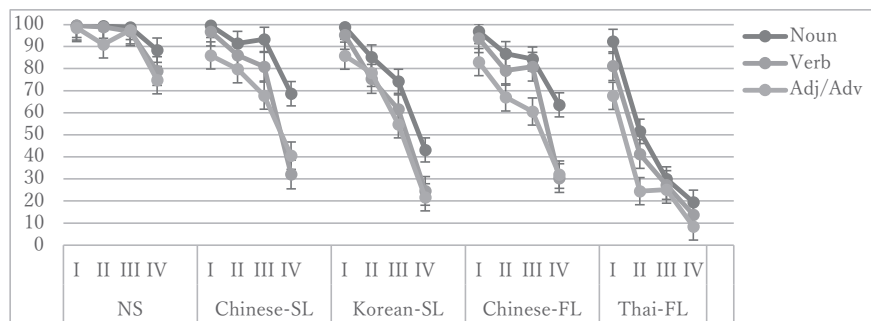
Note. NS = native speakers; SL = second language learners; FL = foreign language learners; Adj/Adv = adjective/adverb; I = most frequent; IV = least frequent.

The CSL group generally showed the noun>verb>adjective/adverb pattern at levels I–III, but their performances were better for adjectives/adverbs than for verbs at level IV. As for the KSL group, although they performed the best with nouns, their performances were similar for verbs and adjectives/adverbs at all frequency levels except at level I. The TFL group showed the noun>verb>adjective/adverb pattern at levels I and II, but their performances were similar across word classes at levels III and IV (except for the noun-adjective/adverb comparison at level IV). The frequency effect was consistent for all word classes for the KSL group (except for the I-II comparison for adjectives/adverbs) and the TFL group (except for the II-III comparison for adjectives/adverbs). The frequency effect was less consistent for the CSL and CFL groups; both groups showed no significant differences between the levels II and III, regardless of word class (except the II-III comparison for the CFL group).

Table 3

Results of ANOVA for effects of frequency level and word class on vocabulary breadth

Group	Frequency level (FL)			Word class (WC)			FL x WC		
	F	p	η^2	F	p	η^2	F	p	η^2
NS	594.92	.0001	.42	.98	n.s.	.00	31.25	.0001	.04
CSL	681.45	.0001	.54	27.39	.0001	.01	35.59	.0001	.06
KSL	747.33	.0001	.58	14.71	.0001	.01	6.13	.0001	.01
CFL	514.18	.0001	.49	20.96	.0001	.01	22.33	.0001	.04
TFL	575.61	.0001	.51	35.46	.0001	.02	6.93	.0001	.01

Note. NS = native speakers; CSL = Chinese second language learners; KSL = Korean second language learners; CFL = Chinese foreign language learners; TFL = Thai foreign language learner.

5.2 Depth of vocabulary: Effects of association type and word class

The reliability of the depth test assessed using Cronbach's alpha indicated high internal consistency for L2 learners (overall = .94, association type = .88–.92) and native speakers (overall = .88, association type = .68–.89). Table

4 presents the descriptive statistics of the depth test. Means and standard errors are shown in Figure 2. The total average scores were 93.1% (SD = 3.6) for the NS group, 76.2% (SD = 8.8) for the CSL group, 74.7% (SD = 6.6) for the CFL group, 70.2% (SD = 12.6) for the KSL group, and 57.6% (SD = 8.1) for the TFL group. The depth test scores had significant moderate to high correlations with the breadth test scores (NS: r = .75; CSL: r = .53; KSL: r = .83; CFL: r = .77; TFL: r = .67; all p < .0001).

Three-way ANOVA for L2 learners revealed significant main effects of association type (F = 300.85, p < .0001, η^2 =.05) and word class (F = 118.04, p < .0001, η^2 =.05). The main effect of group (F = 2.93, p < .05, η^2 =.00) was also significant, but no significant differences were found between pairs according to Tukey's HSD tests. The interactions of group and association type (F = 7.26, p < .0001, η^2 =.00), group and word class (F = 2.28, p < .0001, η^2 =.01), association type and word class (F = 11.97, p < .0001, η^2 =.01), and group $\times$ association type $\times$ word class were all significant (F = 3.58, p < .01, η^2 =.00).

Table 4
Descriptive statistics of the depth test scores by association type and word class

| Group | N | Association type | Word class | | | | | |
| | | | Noun | | Verb | | Adj/v | |
			M	SD	M	SD	M	SD
NS	150	P	96.8	3.2	94.6	3.8	91.8	5.4
		S	91.8	4.5	92.1	4.4	93.4	5.0
Chinese-SL	70	P	89.7	7.5	80.4	11.2	75.0	12.0
		S	76.5	8.4	71.2	10.1	69.8	11.9
Korean-SL	60	P	80.8	13.7	73.6	14.8	73.0	15.0
		S	70.1	11.7	65.0	13.3	66.0	13.8
Chinese-FL	60	P	86.9	6.0	79.3	7.8	76.1	11.9
		S	73.2	7.1	70.6	7.8	69.1	8.4
Thai-FL	94	P	67.6	14,5	54.8	14.1	58.2	14.6
		S	59.8	10.2	55.7	10.0	50.9	11.9

Note. NS = native speakers; SL = second language learners; FL = foreign language learners; Adj/v = adjective/adverb; P = paradigmatic; S = syntagmatic

Figure 2
Depth of vocabulary as a function of association type and word class
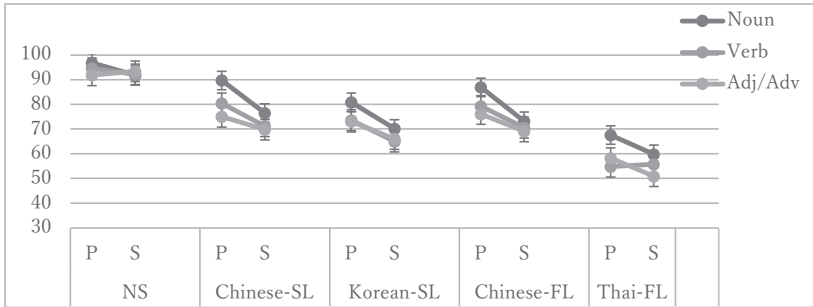
Note. NS = native speakers; SL = second language learners; FL = foreign language learners; Adj/v = adjective/adverb; P = paradigmatic; S = syntagmatic

To examine the effects of association type and word class for each group, two-way ANOVAs were conducted (Table 5). The effect of association type (i.e., paradigmatic > syntagmatic pattern) was significant and robust for the CFL, CSL, and KSL groups, and was modest for the TFL and NS groups. The effect of word class was significant and robust for the CSL, CFL, and TFL groups, and was modest for the KSL and NS groups. The effect of association type-word class interaction was significant for the CSL, CFL, and TFL groups, but not for the KSL group. The association type-word class interaction was also robust for the NS group.

Analyses results of the interaction of association type and word class for all groups are presented in Table B2 (Appendix B). The NS group showed the paradigmatic > syntagmatic pattern across all word classes and the noun>verb>adjective/adverb pattern only for paradigmatic relations. For syntagmatic relations, the NS group performed the best with adjectives/adverbs and the poorest with nouns (though the difference between nouns and verbs was nonsignificant). As for L2 learners, all groups showed the paradigmatic > syntagmatic pattern across word classes, except for the TFL group on the verb class. Regarding the effect of word class on associations

type, all L2 learner groups generally showed the noun>verb>adjective/ adverb pattern for both types of associations. However, for the CSL group, there were no significant differences between verbs and adjectives/adverbs for syntagmatic relations. The CFL group showed no significant differences between verbs and adjectives/adverbs for paradigmatic relations, and between nouns and verbs and verbs and adjectives/adverbs for syntagmatic relations. As for the KSL group, the differences between verbs and adjective/adverbs were not significant for paradigmatic relations, and the differences between nouns and adjectives/adverbs and verbs and adjectives/adverbs were not significant for syntagmatic relations. The TFL group showed no significant differences between verbs and adjectives/adverbs for paradigmatic relations and between nouns and verbs for syntagmatic relations.

Table 5
Results of ANOVA for effects of association type and word class on vocabulary depth

Group	Association type (AT)			Word class (WC)			AT x WC		
	F	p	η^2	F	p	η^2	F	p	η^2
NS	67.57	.0001	.04	18.53	.0001	.02	65.21	.0001	.08
CSL	105.67	.0001	.14	50.09	.0001	.13	6.56	.002	.02
KSL	89.01	.0001	.09	18.48	.0001	.04	1.32	*n.s.*	.00
CFL	207.97	.0001	.23	41.41	.0001	.09	9.01	.0002	.02
TFL	24.89	.0001	.03	38.39	.0001	.09	8.69	.0002	.02

Note. NS = native speakers; CSL = Chinese second language learners; KSL = Korean second language learners; CFL = Chinese foreign language learners; TFL = Thai foreign language learner.

6   Discussion

6.1 Does the breadth of vocabulary knowledge develop similarly for L2 learners with different L1 backgrounds and in different learning environments?

The results of the breadth test indicate that L2 learners, irrespective of L1 background and the learning environment, possess vocabulary knowledge

that is affected by word frequency and class. L2 learners generally can recognize the meaning of higher frequency words better than the meaning of lower frequency words, confirming the effect of frequency on vocabulary size reported in previous studies (Nation, 1990, 2001) and extending it to L2 Japanese. As for word class, L2 learners generally recognize the meaning of nouns better than the meanings of verbs and adjectives/adverbs. This result supports the idea that nouns are easier to learn than verbs and adjectives/adverbs, presumably because of the differences in imageability and abstractness of meaning (Ellis & Beaton, 1993 Saji & Imai, 2013).

However, there were some differences between the L2 learner groups. First, L2 learners with Chinese background (i.e., the CSL and CFL groups) generally performed poorly with adjectives/adverbs than with verbs, whereas L2 learners with Korean background generally performed well with adjectives/adverbs as well as verbs. This difference in groups might be related, at least in part, to the effect of the L1 background or the L1-L2 distance. Because adjectives/adverbs generally occur together with nouns and verbs in sentences, it seems reasonable to suspect that the degree of difficulty (or ease) of processing sentences influences the likelihood of learning adjectives/adverbs contained in the sentences. Korean learners whose L1 is very similar to the target language (TL) at the morphosyntax level may find it easier to process TL sentences, which might facilitate the learning of adjectives/adverbs, compared with Chinese learners whose L1 is morphosyntactically different from TL. This speculation is in line with prior research findings that Korean learners frequently use context information based on the syntactic analysis of the current sentence when inferring the meaning of an unknown word, whereas Chinese learners tend to rely on *kanji/kanjigo* (Yamagata, 2002).

Second, the frequency effect was more consistent for non-Chinese groups than for Chinese groups; Korean and Thai learners performed differently on adjacent frequency levels, whereas the Chinese groups showed no significant differences between levels II and III. This finding may be related to the level assignment of the target words as well as the effect of the L1 background. The

target words at levels II and III may not clearly differ in terms of frequency of occurrence in the real world, and abstract words written in *kanji* at level III may be relatively easy for Chinese learners to recognize (for cognates) or infer their meanings. However, Korean and Thai learners, who are in the process of developing their *kanji* and *kango/kanjigo* knowledge through classroom learning, may be more sensitive to the words they can recognize, resulting in more consistent frequency effects found in their performances.

6.2 Does the depth of vocabulary knowledge develop similarly for L2 learners with different L1 backgrounds and in different learning environments?

The results of the depth test suggest that L2 learners develop knowledge of paradigmatic associations that are stronger and more reliable than knowledge of syntagmatic associations, confirming the previous research findings on receptive word association (Greidanus et al., 2005; Greudanus & Nienhuis, 2001; Horiba, 2012). The results further suggest that, in general, L2 learners' knowledge of word associations is stronger and more reliable for nouns than for other word classes and that the advantage of nouns is more consistent across groups for paradigmatic associations than for syntagmatic associations. Considering the word class effect found for L2 learners in the breadth test, it is not very surprising that L2 learners performed with nouns (i.e., noun → noun) more successfully than with other word classes (i.e., verb → verb, adjective/ adverb → adjective/adverb) for paradigmatic associations. As for syntagmatic associations, the general trend that L2 learners performed better with nouns (i.e., noun → verb, noun → adjective/adverb) than with verbs (i.e., verb → noun, verb → adjective/adverb) and adjectives/adverbs (i.e., adjectives/ adverbs → noun, adjectives/adverbs → verb) suggests that L2 learners may use their strong and reliable knowledge of nouns as anchoring points when processing and recognizing words that collocate or co-occur in the same structure. These results seem to support previous research findings on the effect of word class on productive word association (Nissen & Henriksen,

2006).

However, a closer look at the patterns of interaction between word class and association type revealed some group differences. First, regarding paradigmatic associations, the CSL group performed significantly more poorly with adjectives/adverbs than with verbs, while the KSL group performed equally well with both word classes. As for syntagmatic associations, the CSL group performed significantly more poorly with adjectives/adverbs than with nouns, while the KSL group performed equally well with these word classes. These findings suggest that L2 learners with Korean background possess relatively stronger knowledge of word associations for adjectives/adverbs than their Chinese counterparts. As discussed earlier, Korean learners who are more adept at syntactic processing of sentences may acquire knowledge of adjectives/adverbs more efficiently, whose consequences are presumably reflected, in this case, in syntagmatic as well as paradigmatic associations.

Second, regarding syntagmatic associations, the findings that both the CSL and KSL groups performed significantly better with nouns than with verbs, whereas both the CFL and TFL groups did not show significant differences between nouns and verbs, may suggest some effect of the learning environment. L2 learners residing in the TL environment (i.e., the CSL and KSL groups) have numerous opportunities to experience language use in a variety of communicative contexts in their everyday life, including the use of phrases and collocations containing nouns, both spoken and written. It is possible that such exposure helps L2 learners develop stronger knowledge of syntagmatic associations for nouns. In contrast, classroom-based learners in the foreign language contexts (i.e., the CFL and TFL groups) have severely limited amounts of TL input, and learning materials and exercise activities in the classroom are highly controlled. This kind of practice may have contributed, at least in part, to the patterns of syntagmatic associations for foreign language learners.

Third, the finding that, unlike the other groups, the TFL group performed better (though not significantly) with adjectives/adverbs than with verbs is not expected and is possibly related to multiple factors. Japanese is typologically

different from Thai, and therefore classroom instruction may have a stronger impact on student learning in the foreign language context. Adjectives/adverbs are often presented as a pair or a group (e.g., fast-slow, always-often-sometimes) and are practiced as such in various exercise activities, but verbs are treated differently. The ideas presented here are mostly speculations and therefore future research is needed to address these issues.

6.3 How does the breadth and depth of vocabulary knowledge for L2 learners differ from the native speaker norms?

The results of the breadth test suggest that, irrespective of the language status (i.e., L1 or L2), when learning the form-meaning connections for new words (including level IV for natives), words belonging to some classes (noun) are easier to learn than words belonging to other classes (verb and adjective/adverb). This finding confirms the word class effect (Ellis & Beaton, 1993; Imai et al., 2006) and extends its generalizability to L1 and L2 adults learning Japanese.

As for the depth of vocabulary knowledge, the results suggest that there are both similarities and differences between L2 learners and native speakers. First, the main effect of word class on paradigmatic association was observed for both L2 learners and natives, and interestingly, the noun>verb>adjective/adverb pattern was clearer for the NS group than for the L2 groups (although the NS group did not show a significant main effect of word class in the breadth test). The discrepancy in word class effect between the breadth and depth tests for natives can be explained as follows. The breadth test measures the "shallow" knowledge of form-meaning connections via a receptive multiple choice task. Native speakers who possess highly developed vocabulary knowledge can perform well across all word classes (except for level IV words). In contrast, the depth test measures how the words are semantically related to each other. To recognize a paradigmatically related word, one needs to access the "deep" knowledge of how words are categorically/conceptually related to each other. Therefore, native speakers' performances on the

depth test more clearly reflect the structural characteristics of vocabulary knowledge, which varies depending on the word class.

Second, the analyses of the association type-word class interaction revealed strikingly different patterns between native speakers and L2 learners. The findings that natives performed the best with adjectives/adverbs and the poorest with nouns for syntagmatic associations and that their performance with adjectives/adverbs was significantly better for syntagmatic associations than for paradigmatic associations are in line with previous research on L1 Dutch (De Deyne & Storms, 2008). The phenomenon that adjective-syntagmatic and noun-paradigmatic connections are strong in word association knowledge, as suggested by previous research (De Deyne & Storms, 2008), may be universal and can explain L1 Japanese adults' word association performances in the present study.

In contrast, because nouns are much easier to learn than the other word classes for L2 learners, their knowledge of syntagmatic associations for nouns develops more strongly and is more accessible than their syntagmatic association knowledge for verbs and adjectives/adverbs. Nouns have more concrete meanings, are imageable, and have clear boundaries, whereas verbs and adjectives/adverbs have meanings that are ambiguous or relative and have fuzzy boundaries (Ellis & Beaton, 1993; Imai et al., 2006). Therefore, it is possible that L2 learners, irrespective of their L1 background, tend to rely on nouns and use them as anchoring points when processing words that collocate or co-occur in sentences. Obviously, this idea needs to be directly investigated in future research.

7．Conclusion

The present study investigated the breadth and depth of vocabulary knowledge in L1 and L2 Japanese, and while confirming some of the previous research findings, the study also produced new evidence regarding the effect of frequency, word class, and association type on vocabulary development. It was found that some characteristics of L2 vocabulary knowledge may be

differentially affected by learners' L1 background and learning environment. Furthermore, some characteristics of word association knowledge networks (i.e., syntagmatic relations) seem to clearly differentiate between L2 learners and native speakers.

There are some limitations of the study, as well as newly derived questions that need to be addressed in future research. First, although the vocabulary tests were developed with utmost care, the target word selection was not based on any formal assessment of frequency because there were no such corpora available at the time of test development. Much research is needed to develop a valid and reliable measure of vocabulary knowledge in L2 Japanese. Second, because receptive written vocabulary tests were used, L2 learners' performances were strongly affected by L1-L2 distance at the orthographic level. The relationship between written and oral vocabulary, as well as receptive and productive vocabulary in L2 Japanese, needs to be investigated. Third, the development of vocabulary knowledge networks was not directly examined but inferred based on the receptive vocabulary test results. Further research is needed to directly investigate knowledge development using a longitudinal study design. Fourth, the tests used were rather long and cognitively demanding for some learners. The possible effects of other variables, such as learner attitudes and test-taking strategies, were beyond the scope of this study. Future research should take these factors into consideration.

Notes

[1] The assignment of words to each level of the JLPT was based on the content specifications developed by the JLPT Planning Committee (Ministry of Education, Culture, Sports, Science and Technology). The committee scrutinized seven corpora and research reports (prepared by the National Language Research Institute during 1964–1987) on vocabulary use in the general public and in junior/high school textbooks and 11 Japanese language textbooks (Japan Foundation, 2002). Based on the descriptions of the content specifications (Japan Foundation, 2002), the words assigned to the two highest levels (i.e., 1st and 2nd levels) were selected from the same corpora; the words for

the 1st level were selected first and then the words occurring more frequently in different corpora were selected for the 2nd level.

[2] More specifically, for target words in levels I, II, and III, we randomly selected 498 words as candidates (4th level: 102 words, 3rd level: 160 words, 2nd level: 134 words, and 1st level: 102 words) from the word corpus of the JLPT, consisting of 728 4th level words, 1,409 3rd level words, 5,035 2nd level words, and 8,009 1st level words. For the target words in the IV level, we selected 294 candidates by consulting various dictionaries (e.g., Shibata et al., 1995, 2002; Yamaguchi, 2003). The selection of level IV target words was based on the following criteria: 1) the word is not listed in the corpus of the JLPT and is judged to be more difficult than the words in the 1st level of the JLPT; 2) the word is not a technical word but a general word used less frequently and in a more specialized context. A team of 12 applied linguists who had experience in language teaching used the candidate words to develop the vocabulary tests. During the course of test development, more than 800 words were considered as possible target words. Careful considerations were made, particularly regarding word features such as word class, semantic category, intra-word structure, word type, and orthography. Through numerous cross examinations of the materials and pilot tests, final decisions were made concerning the target words and test items. It was also ensured that there was no overlapping of words used for distractors and definitions (in the breadth test, except for very basic words such as 'thing' and 'be') throughout the items of the two tests.

Acknowledgements

References

Aitchison, J. (1994). *Words in the mind: An introduction to the mental lexicon* (2nd ed.). Oxford, UK: Blackwell.

Bernhardt, E. B., & Kamil, M. L. (1995). Interpreting relationships between L1 and L2 reading: Consolidating the linguistic threshold and the linguistic interdependent hypothesis.

Applied Linguistics, 16, 15-34.

Bultena, S., Dijkstra, T., & van Hell, J. G. (2014). Cognate effects in sentence context depends on word class, L2 proficiency, and task. *Quarterly Journal of Experimental Psychology, 67*, 1214-1241.

De Deyne, S., & Storms, G. (2008). Word associations: Network and semantic properties. *Behavior Research Methods, 40*, 213-231.

Ellis, N. C. (2012). Frequency-based accounts of SLA. In S. M. Gass & A. Mackey (Eds.), *Handbook of Second Language Acquisition* (pp. 193–210). New York: Routledge.

Ellis, N. C., & Beaton, A. (1993). Psycholinguistic determinants of foreign language vocabulary learning. *Language Learning*, *43*, 559-617.

Fitzpatrick, T. (2012). Tracking the changes: vocabulary acquisition in the study abroad context. *The Language Learning Journal*, *40*, 81–98.

Fitzpatrick, T., & Thwaites, P. (2020). Word association research and the L2 lexicon. *Language Teaching, 53*, 1-38.

Greidanus, T., Beks, B., & Wakely, R. (2005). Testing the development of French word knowledge by advanced Dutch- and English-speaking learners and native speakers. *The Modern Language Journal, 89,* 221-233.

Greidanus, T., & Nienhuis, L. (2001). Testing the quality of word knowledge in a second language by means of word associations: Types of distractors and types of associations. *The Modern Language Journal, 85,* 567-577.

Haastrup, K., & Henriksen, B. (2000). Vocabulary acquisition: Acquiring depth of knowledge through network building. *International Journal of Applied Linguistics, 10,* 221–239.

Henriksen, B. (1999). Three dimensions of vocabulary development. *Studies in Second Language Acquisition, 21,* 303–317.

Henriksen, B. (2008). Declarative lexical knowledge. In D. Albrechtsen, K. Haastrup & B. Henriksen (Eds.), *Vocabulary and writing in a first and second language: Processes and development* (pp. 22–66). New York: Macmillan.

Horiba, Y. (2012). Word knowledge and its relation to text comprehension: A comparative study of Chinese- and Korean-speaking L2 learners and L1 speakers of Japanese. *The Modern Language Journal, 96,* 108–121.

Imai, M., Haryu, E., Okada, H., Li, L., & Shigematsu, J. (2006). Revisiting the noun-verb debate: A crosslinguistic comparison of novel noun and verb learning in English, Japanese- and Chinese-speaking children. In K. Hirsh-Pasek & R. M. Golinkoff (Eds.), *Action meets word: How children learn verbs* (pp. 450–476). Oxford, UK: Oxford University Press.

Japan Foundation (2002). *Nihongo-noryoku-shiken shutsudai kijun* [Standards for questions in the Japanese language proficiency test]. Tokyo: Bonjinsha.

Japan Foundation (2020). *Kaigai no nihongo-kyouiku no genjo: 2018-nendo nihongo-kyouiku-kikan chousa yori* [Survey report on Japanese-language education abroad 2018]. Tokyo: The Japan Foundation.

Jarvis, S., & Pavlenko, A. (2008). *Crosslinguistic Influence in Language and Cognition.* London: Routledge.

Koda, K., & Mitsugi, S. (2007). Word knowledge development in a second language. *Acquisition of Japanese as a Second Language, 10,* 87-113.

Laufer, B. (1997). The lexical plight in second language reading: Words you don't know, wods you think you know and words you can't guess. In J. Coady & T. Huckin (Eds.), *Second language vocabulary acquisition: A rationale for pedagogy* (pp. 20-33). Cambridge: Cambridge University Press.

Meara, P. (1996). The dimensions of lexical competence. In G. Brown, K. Malmkjaer & J. Williams (Eds.), *Competence and performance in language learning* (pp. 35-53). New York: Cambridge University Press.

Meara, P. (2009). *Connected words: Word associations and second-language vocabulary acquisition.* Amsterdam: John Benjamins.

Nation, I. S. P. (1990). *Teaching and learning vocabulary*. Rowley, MA: Newbury House.

Nation, I. S. P. (2001). *Learning vocabulary in another language.* New York: Cambridge University Press.

Nation, I. S. P., & Webb, S. A. (2011). *Researching and analyzing vocabulary.* Boston MA: Heinle.

Nissen, H. B., & Henriksen, B. (2006). Word class influence on word association test results. *International Journal of Applied Linguistics, 16,* 389-408.

Odlin, T. (2003). Cross-linguistic influence. In C. J. Doughty & M. H. Long (Eds.), *The Handbook of Second Language Acquisition* (pp. 436-486). Oxford: Blackwell.

Otwinowska, A., & Szewczyk, J. M. (2019). The more similar the better? Factors in learning cognates, false cognates and non-cognate words. *International Journal of Bilingual Education and Bilingualism, 22, 974-991.*

Qian, D. D. (2002). Investigating the relationship between vocabulary knowledge and academic reading performance: An assessment perspective. *Language Learning, 52,* 513-536.

Read, J. (1993). The development of a new measure of L2 vocabulary knowledge. *Language Testing, 10,* 355-371.

Read, J. (1998). Validating a test to measure depth of vocabulary knowledge. In A. J. Kunnan (Ed.), *Validation in language assessment* (pp. 41-60). Mahwah, NJ: Lawrence Erlbaum.

Read, J. (2000). *Assessing Vocabulary.* New York: Cambridge University Press.

Read, J. (2004). Plumbing the depths: How should the construct of vocabulary knowledge

be defined? In P. Bogaards & B. Laufer (Eds.), *Vocabulary in a second language. Selection, acquisition, and testing* (pp. 209—227). Philadelphia, PA: John Benjamins.

Saji, N., & Imai, M. (2013). Evolution of verb meanings in children and L2 adult learners through reorganization of an entire semantic domain: The case of Chinese carry/hold verbs. *Scientific Research in Reading, Special issue: Research in Chinese, 17*, 71-88.

Schepens, J. J., van der Silk, F., & van Hout, R. (2016). L1 and L2 distance effects in learning L3 Dutch. *Language Learning, 66,* 224-256.

Schmitt, N. (1998). Tracking the incremental acquisition of second language vocabulary: A longitudinal study. *Language Learning, 48,* 281–317.

Schmitt, N. (2000). *Vocabulary in language learning*. Cambridge, UK: Cambridge University Press.

Schmitt, N. (2014). Size and depth of vocabulary knowledge: What the research shows. *Language Learning, 64,* 913-951.

Shibata, T., et al. (Eds.). (1995). *Shinmeikai kokugo-jiten* [New lucid Japanese dictionary]. (4th ed.) . Tokyo: Sanseido.

Shibata, T., et al. (Eds.). (2002). *Ruigo-daijite*n [Synonym dictionary]. Tokyo: Kodansha.

Stæhr, L. S. (2008). Vocabulary size and the skills of listening, reading and writing. *Language Learning Journal, 36,* 139-152.

Wesche, M., & Paribakht, T. S. (1996). Assessing second language vocabulary knowledge: Depth versus breadth. *The Canadian Modern Language Journal Review, 53,* 13-40.

Yamagata, J. (2002). *Nihongo*-gakushuusha no tekusuto-rikai ni okeru michigo no imi-suisoku: L2-chishiki to bogo-haikei ga oyobosu eikyou [Lexical inferencing in reading comprehension for leaners of Japanese: Effects of L2 knowledge and L1 background]. *Teaching Japanese as a Foreign Language, 139*, 42-51.

Yamaguchi, T. (Ed.). (2003). *Nihongo dai-thesaurus: Ruigo-kensaku daijiten* [Synonym dictionary]. Tokyo: Taishukan.

Zareva, A. (2007). Structure of the second language mental lexicon: How does it compare to native speakers' lexical organizations? *Second Language Research, 23,* 123-153.

Zareva, A., Schwanenflugel, P., & Nikolova, Y. (2005). Relationship between lexical competence and language ability: Variable sensitivity. *Studies in Second Language Acquisition, 27,* 567-595.

Zareva, A., & Wolter, B. (2012). The 'promise' of three methods of word association analysis to L2 lexical research. *Second Language Research, 28*, 41-67.

Appendix A

The example provided in the breadth test
例：
1．市
2．デパート 　　　5　　　 木の多いところ。
3．場合 　　　4　　　 これで書く。
4．ペン 　　　6　　　 食べ物。
5．森
6．りんご

{The English translation (not provided in the actual test):

Example:

1．city

2．department store 　　　5　　　 A place with lots of trees.

3．situation 　　　4　　　 Write with this.

4．pen 　　　6　　　 Food.

5．forest

6．apple 　　　　　　　　　　　　　　　　 }

The examples provided in the depth test
例1　　りんご

| 赤い　　あした　　悲しい　　切る　　果物　　読む |

ヒント (hint)：　りんご は 果物です。
　　　　　　　　　赤い りんご
　　　　　　　　　りんご を 切る

例2　　簡単

| おなか　　できる　　必要　　メートル　　問題　　やさしい |

ヒント (hint)：　「簡単」と「やさしい」は意味が似ています。
　　　　　　　　　簡単に できる
　　　　　　　　　簡単な 問題

例3　続ける

カーテン　　(仕事)　　知る　　(する)　　どうも　　(長い)

ヒント (hint)：　「続ける」ことは「する」ことです。
　　　　　　　　仕事 を 続ける
　　　　　　　　長く 続ける

{The English translation (not provided in the actual test):

Ex. 1　apple

(red)　　tomorrow　　sad　　(to cut)　(fruit)　　to read

hint: An apple is a fruit.
　　　a red apple
　　　cut an apple

Ex. 2　simple

stomach　(can do)　necessary　　meter　(question)　(easy)

hint: 'Simple' and 'easy' are similar in meaning.
　　　can do it simply
　　　a simple question

Ex. 3　to continue

curtain　(job)　　to know　(to do)　very much　(long)

hint: 'To continue' is 'to do.'
　　　continue to the job
　　　continue for a long time

Appendix B
Table B1.

Tukey's HSD tests for the effect of interaction of frequency level and word class on vocabulary breadth

Group		Comparison	Mean difference	± 95%CI		p
				LL	UL	
NS	N	I - II	0.31	-2.51	3.13	*n.s.*
		II - III	0.62	-2.20	3.44	*n.s.*
		III- IV	10.27	7.44	13.09	< .05
	V	I - II	0.62	-2.20	3.45	*n.s.*
		II - III	1.96	-0.87	4.78	*n.s.*
		III- IV	17.96	15.13	20.78	< .05
	A	I - II	7.55	4.73	10.38	< .05
		II - III	-6.44	-9.27	-3.62	< .05
		III- IV	22.59	19.77	25.41	< .05
	I	N - V	0.18	-2.65	3.00	*n.s.*
		N - A	1.13	-1.70	3.95	*n.s.*
		V - A	0.95	-1.88	3.77	*n.s.*
	II	N - V	0.49	-2.33	3.31	*n.s.*
		N - A	8.37	5.55	11.19	< .05
		V - A	7.88	5.06	10.70	< .05
	III	N - V	1.82	-1.00	4.65	*n.s.*
		N - A	1.30	-1.52	4.13	*n.s.*
		V - A	-0.52	-3.34	2.30	*n.s.*
	IV	N - V	9.51	6.69	12.33	< .05
		N - A	13.63	10.80	16.45	< .05
		V - A	4.12	1.29	6.94	< .05
Chinese -SL	N	I - II	8.19	1.85	14.54	< .05
		II - III	-1.90	-8.25	4.44	*n.s.*
		III- IV	24.67	18.32	31.01	< .05
	V	I - II	10.67	4.32	17.01	< .05
		II - III	5.24	-1.11	11.58	*n.s.*
		III- IV	48.76	42.42	55.11	< .05
	A	I - II	6.19	-0.15	12.54	*n.s.*
		II - III	12.06	5.72	18.41	< .05
		III- IV	27.15	20.80	33.49	< .05
	I	N - V	2.86	-3.49	9.20	*n.s.*
		N - A	13.59	7.24	19.93	< .05
		V - A	10.73	4.38	17.07	< .05

	II	N - V	5.33	-1.01	11.68	*n.s.*
		N - A	11.59	5.24	17.93	< .05
		V - A	6.25	-0.09	12.60	*n.s.*
	III	N - V	12.48	6.13	18.82	< .05
		N - A	25.55	19.21	31.90	< .05
		V - A	13.08	6.73	19.42	< .05
	IV	N - V	36.57	30.23	42.92	< .05
		N - A	28.03	21.69	34.38	< .05
		V - A	-8.53	-14.88	-2.19	< .05
Korean -SL	N	I - II	13.45	5.40	21.49	< .05
		II - III	11.00	2.95	19.04	< .05
		III- IV	31.11	23.07	39.16	< .05
	V	I - II	19.89	11.84	27.93	< .05
		II -FIII	13.89	5.84	21.93	< .05
		III- IV	37.00	28.96	45.04	< .05
	A	I - II	7.78	-0.27	15.82	*n.s.*
		II - III	22.33	15.29	31.38	< .05
		III- IV	33.15	25.11	41.19	< .05
	I	N - V	3.44	-4.60	11.49	*n.s.*
		N - A	11.85	4.81	20.90	< .05
		V - A	9.41	1.36	17.45	< .05
	II	N - V	9.89	1.84	17.93	< .05
		N - A	7.18	-0.86	15.22	*n.s.*
		V - A	-2.71	-10.75	5.34	*n.s.*
	III	N - V	12.78	4.73	20.82	< .05
		N - A	19.52	11.47	27.56	< .05
		V - A	6.74	-1.30	14.79	*n.s.*
	IV	N - V	18.67	10.62	26.71	< .05
		N - A	21.56	13.51	29.60	< .05
		V - A	2.89	-5.15	10.93	*n.s.*
Chinese -FL	N	I - II	10.11	2.71	17.52	< .05
		II - III	2.33	-5.07	9.74	*n.s.*
		III- IV	20.89	13.48	28.29	< .05
	V	I - II	14.67	7.26	22.07	< .05
		II - III	-1.78	-9.18	5.63	*n.s.*
		III- IV	50.44	43.04	57.85	< .05
	A	I - II	15.93	8.52	23.33	< .05
		II - III	6.48	-0.92	13.88	*n.s.*
		III- IV	28.52	21.12	35.93	< .05

I	N - V	3.11	-4.29	10.52	*n.s.*
	N - A	13.93	6.52	21.33	< .05
	V - A	10.81	3.41	18.22	< .05
II	N - V	7.67	0.26	15.07	< .05
	N - A	19.74	12.33	27.14	< .05
	V - A	12.07	4.67	19.48	< .05
III	N - V	3.56	-3.85	10.96	*n.s.*
	N - A	23.89	16.48	31.29	< .05
	V - A	20.33	12.93	27.74	< .05
IV	N - V	33.11	25.71	40.52	< .05
	N - A	31.52	24.12	38.93	< .05
	V - A	-1.59	-9.00	5.81	*n.s.*
Thai -FL	N	I - II	40.78	31.18	50.37	< .05
		II - III	21.63	12.03	31.23	< .05
		III- IV	10.46	0.86	20.06	< .05
	V	I - II	39.89	30.29	49.49	< .05
		II - III	14.01	4.41	23.60	< .05
		III- IV	13.48	3.88	23.07	< .05
	A	I - II	43.26	33.67	52.86	< .05
		II - III	-0.71	-10.31	8.89	*n.s.*
		III- IV	16.67	7.07	26.26	< .05
	I	N - V	11.17	1.57	20.77	< .05
		N - A	24.64	15.04	34.24	< .05
		V - A	13.47	3.88	23.07	< .05
	II	N - V	10.28	0.69	19.88	< .05
		N - A	27.13	17.53	36.73	< .05
		V - A	16.84	7.25	26.44	< .05
	III	N - V	2.66	-6.94	12.26	*n.s.*
		N - A	4.79	-4.81	14.39	*n.s.*
		V - A	2.13	-7.47	11.73	*n.s.*
	IV	N - V	5.67	-3.92	15.27	*n.s.*
		N - A	10.99	1.40	20.59	< .05
		V - A	5.32	-4.28	14.92	*n.s.*

Note. CI = confidence interval; LL = lower limit; UL = upper limit; NS = native speakers; SL = second language learners; FL = foreign language learners; N = noun; V = verb; A = adjective/adverb; I = most frequent; IV = least frequent.

Table B2.

Tukey's HSD tests for the effect of interaction of association type and word class on vocabulary depth

Group	Comparison		Mean difference	± 95%CI		p
				LL	UL	
NS	N	P - S	5.03	3.85	6.21	< .05
	V	P - S	2.45	1.27	3.63	< .05
	A	P - S	-1.59	-2.77	-0.41	< .05
	P	N - V	2.28	1.10	3.46	< .05
		N - A	5.09	3.90	6.27	< .05
		V - A	2.81	1.63	3.99	< .05
	S	N - V	-0.30	-1.48	0.88	*n.s.*
		N - A	-1.54	-2.72	-0.35	< .05
		V - A	-1.24	-2.42	-0.06	< .05
Chinese -SL	N	P - S	13.16	8.73	17.58	< .05
	V	P - S	9.13	4.71	13.56	< .05
	A	P - S	5.24	0.81	9.66	< .05
	P	N - V	9.31	4.88	13.74	< .05
		N - A	14.67	10.24	19.09	< .05
		V - A	5.36	0.93	9.78	< .05
	S	N - V	5.29	0.86	9.71	< .05
		N - A	6.75	2.32	11.18	< .05
		V - A	1.46	-2.96	5.89	*n.s.*
Korean -SL	N	P - S	10.72	6.10	15.35	< .05
	V	P - S	8.65	4.03	13.28	< .05
	A	P - S	7.01	2.39	11.64	< .05
	P	N - V	7.14	2.51	11.77	< .05
		N - A	7.77	3.14	12.40	< .05
		V - A	0.63	-4.00	5.26	*n.s.*
	S	N - V	5.07	0.44	9.70	< .05
		N - A	4.06	-0.57	8.69	*n.s.*
		V - A	-1.01	-5.64	3.62	*n.s.*
Chinese -FL	N	P - S	13.74	10.37	17.10	< .05
	V	P - S	8.64	5.27	12.01	< .05
	A	P - S	6.97	3.60	10.33	< .05
	P	N - V	7.61	4.24	10.98	< .05
		N - A	10.78	7.41	14.14	< .05
		V - A	3.17	-0.20	6.53	*n.s.*

	S	N - V	2.51	-0.85	5.88	*n.s.*
		N - A	4.01	0.64	7.38	< .05
		V - A	1.50	-1.87	4.86	*n.s.*
Thai	N	P - S	7.82	3.12	12.52	< .05
-FL	V	P - S	-0.85	-5.55	3.85	*n.s.*
	A	P - S	7.23	2.53	11.92	< .05
	P	N - V	12.77	8.07	17.46	< .05
		N - A	9.45	4.75	14.15	< .05
		V - A	-3.32	-8.01	1.38	*n.s.*
	S	N - V	4.10	-0.60	8.79	*n.s.*
		N - A	8.86	4.16	13.55	< .05
		V - A	4.76	0.06	9.46	< .05

Note. CI = confidence interval; LL = lower limit; UL = upper limit; NS = native speakers; SL = second language learners; FL = foreign language learners; P = paradigmatic; S = syntagmatic; N = noun; V = verb; A = adjective/adverb.