JESLA Journal of the European Second Language Association

Matsuno, K. (2017). Processing collocations: Do native speakers and second language learners simultaneously access prefabricated patterns and each single word? *Journal of the European Second Language Association,* 1(1), 61–72, DOI: https://doi.org/10.22599/jesla.17

RESEARCH

Processing collocations: Do native speakers and second language learners simultaneously access prefabricated patterns and each single word?

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The purpose of this study was to examine whether native English speakers and Japanese ESL (English as a Second Language) learners concurrently access prefabricated patterns as well as each word in these patterns when collocation meanings are retrieved. Previous studies have tended to focus on either holistic or analytic solo processing; however, there is the further possibility that single-word knowledge is simultaneously activated when prefabricated patterns are accessed. With this possibility, this study examined the possible parallel processing of collocations. Two experiments were conducted with 30 native English speakers and 30 advanced Japanese ESL learners. It was found that (1) the native speakers (NSs) generally processed collocations in parallel, but some collocations were solely processed; and (2) ESL learners generally used sole processing and tended to use fewer prefabricated patterns than the NSs. From these findings, it was suggested that the ESL learners processed collocations differently from NSs even after the knowledge of collocations had been acquired. This provides some evidence that dealing with simultaneous processes is challenging for ESL learners.

Keywords: Collocations; Language processing; Parallel processing; Japanese ESL learners

1. Introduction

1.1 Collocations

Firth (1957) stated that "collocations are actual words in habitual company" (p. 182) and a syntagmatic co-occurrence of words. Howarth (1998) mentioned that "The continuum is distributed across three major categories: free combinations, restricted collocations, and idioms" (p. 164). In other words, collocations lie between freely combining word combinations and frozen idioms (Van Lancker, 1975). According to Hill and Lewis (1997), collocation is "one of the most powerful forces in making language coherent, fluent, comprehensible, and predictable" (p. 1).

The definition of collocations as "habitual" word combinations could be seen to be somewhat abstract and vague. In addition to the criterion of a co-occurrence of words, three further criteria have been employed in previous studies. First, recurrent word combinations have generally been regarded as collocations (Bartsch, 2004; Clear, 1993; Sinclair, Johns & Daley, 2004). The examples of highly frequent word combinations from previous studies are as follows (Hill & Lewis, 2002, p. 7): *a big house*, *give a quick report*, *very different,* and *rather strong*. Word association strength has also been seen as a collocation criterion (Gregory, Raymond, Bell, Fosler-Lussier & Jurafsky, 1999), in which there is "the tendency of words to be biased in the way they co-occur" (Hunston, 2002, p. 68). To measure the strength of such word combinations, several measures have been developed such as the MI-score, t-score, Z-score, G-score, entropy, dice, cost criteria, and gravity counts (Daudaravičius & Marcinkevičienė, 2004; Kita, Kato, Omoto & Yano, 1994; Schütze, 1999). The third collocational criterion is synonym substitution (Greenbaum, 1970; Lehrer, 1974). For example, Carter and McCarthy (1988) explained that *strong tea* was a collocation because *powerful* could not be used with *tea* but *strong* could, even though *strong* and *powerful* have similar meanings in some contexts. **Table 1** shows the word combination examples for *strong* and *powerful*.

However, with the third criterion, it seems to be difficult to determine the synonym(s) for the modifying word for judging whether a word combination is a collocation. As an example, according to Firth (1952),

Table 1: Word combination examples for *strong* and *powerful.*

	argument	**tea**	**car**
strong	X	X	
powerful	X		X

Note. Based on Carter and McCarthy (1988, p. 34).

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> the synonyms for the verb *get* are (a) have, hold, possess, grasp, grip, catch; (b) secure, obtain, procure, acquire; (c) earn, profit, gain; (d) am, is, etc., grow, become; (e) progress, advance, arrive, reach; (f) obliged, force, forced; (g) succeed, surmount, subdue, defeat, overcome, overpower; (h) contrive, extricate, insert, apply, escape, avoid; (i) learn, understand, express. (p. 23)

When attempting to determine whether a word combination containing *get* is a collocation, it appears to be tricky to judge which synonym(s) is/are the correct substitute to determine whether an expression is a collocation.

Previous studies also have two additional collocation criteria. The first is whether the word combinations contain a grammatical structure. Some researchers have claimed that a collocation has grammatical structure. For example, Kjellmer (1991) stated, "Collocations are defined as recurring sequences that have grammatical structure" (p. 116). However, others have stated that collocations do not require grammatical structures (Kennedy, 1991, 1998). The second criterion is continuity. According to Palmer (1933), "A collocation is a succession of two or more words that must be learnt as an integral whole and not pieced together from its component parts" (title page), and Biber et al. (1998) said, "Words do not necessarily need to be adjacent to be associated with each other. That is, two words may tend to co-occur even with a few other words between them" (p. 51). To investigate the processing of collocations (that is, habitual word combinations), this study sampled word combinations with (1) high-strength relationships that (2) had grammatical structures and (3) were not necessarily continuous.

1.2 Language processing

Townsend and Bever (2001) stated that "mental processes in general and linguistic processes in particular come in two flavors—habits and computations" (p. 1); that is, "customs and rules" (Firth, 1975, p. 179). Sinclair (1991) said rule-based language processing operated on an open-choice principle, explaining the idiom principle for language processing in customs. Sinclair (1991) also described "the idiom principle" as "the choice of one word affects the choice of others in its vicinity" (p. 173), and Pawley and Syder (1983) stated that these "memorized sequences. These strings ... which on most occasions of use are recalled as whole or as automatically chained strings" (p. 205). Memorized sequences have also been referred to as prefabricated expressions, prefabricated patterns, and expressions stored as a unit. This study classified the above two language processing types as analytic processing (where the grammar and vocabulary are computed, and the meanings of the word combinations are retrieved by combining each word's meaning) and holistic processing (where word combinations are memorized as units, and the meanings for the word combinations are retrieved as a whole). In analytic processing, free, novel, or creative word combinations can be produced or understood, but in holistic processing, the word combinations are effortlessly conducted with less processing load and a faster processing speed (Peters, 1983; Wray, 1999; Wray & Perkins, 2000).

Kjellmer (1991) noted that "A large part of our mental lexicon consists of combinations of words that customarily co-occur" (p. 112), and Erman and Warren (2000) demonstrated in their corpus study that holistic processing was not uncommon or peripheral. For instance, idioms are generally thought to be processed holistically—specifically, the lexical representation hypothesis (Swinney & Cutler, 1979), the direct access hypothesis (Gibbs, 1980), and the configuration model (Cacciari & Tabossi, 1988) have been suggested by employing the reaction time paradigm and priming paradigm research. Phrasal verbs (Matlock & Heredia, 2002) and compounds (Hillert & Swinney, 2001) have also been revealed to have holistic processing elements. Underwood, Schmitt, and Galpin (2004) conducted eye movement research that showed evidence supporting "the position that formulaic sequences are stored and processed holistically" (p. 167). The reaction time research of Jiang and Nekrasova (2007) provided "the evidence in support of the holistic nature of formulaic resresentation and processing" in NSs and second language (L2) speakers (p. 433).

Kemmer and Barlow (2000) proposed that language use helps to develop a memory of prefabricated patterns, which is referred to as the usage-based model. "Since it is based on experience, this type of learning should be influenced by how frequently specific patterns occur" (Townsend & Bever, 2001, p. 2). In other words, "A form becomes stronger when it occurs more frequently" (MacWhinney, 2001, p. 464), and "high frequency phrases are stored in memory" (Bybee & Hopper, 2001, p. 17). Wray (2002) noted that "the more often a string is needed, the more likely it is to be stored in prefabricated form to save processing effort" (p. 25).

1.3 Language learners and collocations

Singleton (2000) stated that "we need to know about collocational patterns in order to function smoothly in lexical terms in either our mother tongue or any other language we may know" (p. 56). However, as Kjellmer (1991) noted, NSs make use of large prefabricated sections, whereas "[t]he learner, on the other hand, having automated few collocations, continually has to create structure" (p. 124). Previous studies have found that even advanced learners made mistakes when producing collocations, and L1 transfer was also observed in their errors (Farghal & Obiedat, 1995; Nesselhauf, 2005). The research of Siyanova and Schmitt (2008) showed that "the underlying the intuitions and fluency with collocations of even advanced learners do not seem to match those of native speakers" (p. 429). Moreover, an investigation of reaction time by Yamashita and Jiang (2010) showed that "EFL leaners made more errors with and reacted more slowly to incongruent collocations than congruent collocations" (p. 647), but Wolter and Gyllstad (2013) found that "advanced learners are highly sensitive to frequency effects for L2 collocations" (p. 451).

2. Research Questions

Previous studies have tended to focus more on solo processing, that is – holistic or analytic processing. However, there is a further possibility that the knowledge of single words is simultaneously activated while prefabricated patterns are being accessed. Therefore, the current study proposes the parallel language processing model and examined collocational processing from a parallel processing viewpoint, in which both analytic and holistic processing were integrated. Therefore, the research questions (RQs) this study sought to establish were as follows.

RQ1: Which of the following models were generally employed when NSs and L2 learners processed collocations? (1) Solo: only analytic processing, (2) solo: only holistic processing or (3) parallel: both analytic and holistic processing?

RQ2: How was each individual collocation processed?

RQ3: How was the collocation processing of learners influenced by their learning experience?

Figure 1 illustrates the parallel language processing model, in which the analytic processing was based on Jiang (2000), Kintsch (1998), Levelt (1989, 1993), and McClelland (1987).

In parallel processing, because of elements such as spoken utterances and written text, with or without context, and the degree of predictivity of the co-occurring words, the time it takes to start recognizing the prefabricated patterns was expected to differ. As an example of the parallel language processing model, when the sentence *He made a decision* is to be understood using analytic processing, each word (*he*, *made*, *a*, *decision*) is recognized, and the word information is retrieved. After all or some of the semantic, syntactic, morphemic, and phonological/orthographic information in each word is accessed, the declension and tense emerge. For example, the lemma for *made* (=*make*) would be retrieved, as well as the information about the past tense. Then, if necessary, the grammar would be analyzed. On the other hand, if the collocational pattern for *make* and *decision* is memorized, in parallel with analytic processing, after the memorized word pattern (=*make* used with *decision*) is recognized, its attached pattern information (e.g., the meaning of the prefabricated unit) is retrieved, and the expression is understood.

Some collocations have inflections and/or syntactic operations (For instance, *decision* and *make* are used in the phrase *make a decision*, *make decisions*, *decisions to be made*, *made an important decision*, etc.), and thus this study describes word combinations as "*A* + *B*" such as *make* + *decision*.

3. General Experimental Design

In order to examine the processing of collocation, two experiments were conducted on NSs and ESL learners. The first experiment examined whether collocations were processed as a unit, and the second experiment investigated whether the single words that made up the prefabricated patterns were accessed. After two experiments, one questionnaire was conducted on learners to examine the influence of the learning experience.

Experiment 1 compared the reaction times between the collocations and the free combinations, using a phrase decision task.[1] To ensure that the free combinations corresponded to the collocations, verbs processed in the same reaction time as those in the collocations were extracted, and then the same nouns were combined with those verbs. For example, based on *blow my nose* (collocation),

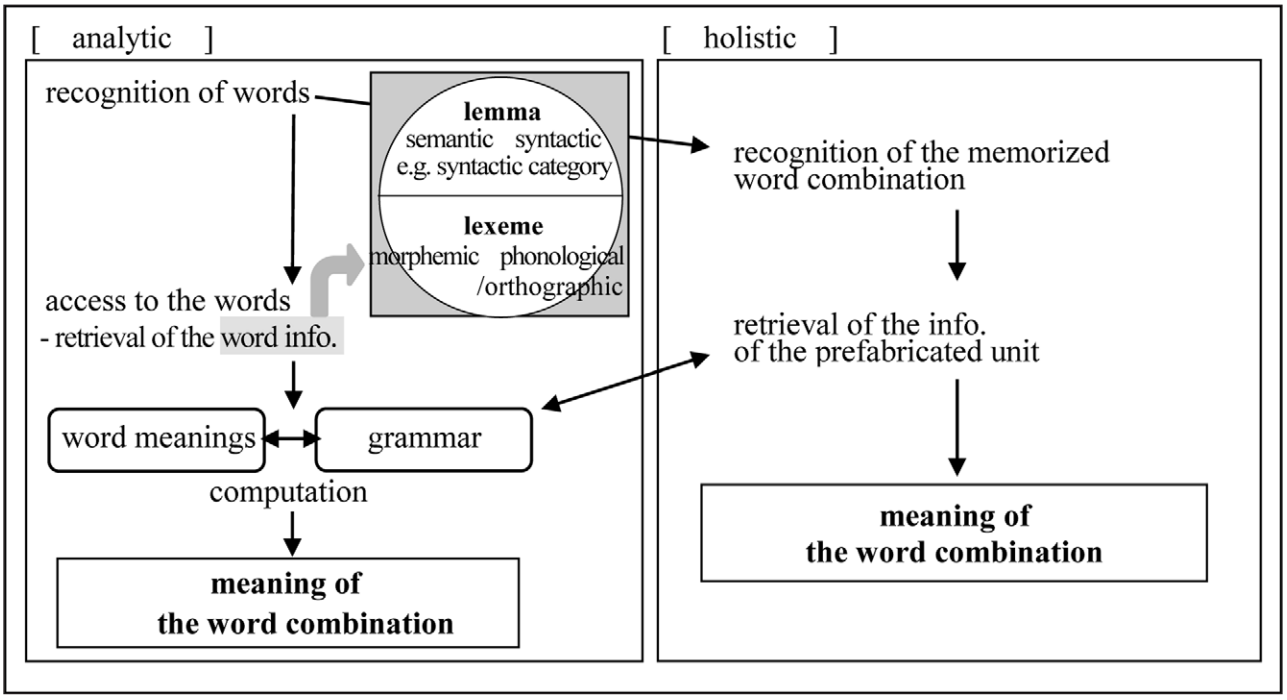

Figure 1: Parallel language processing model.

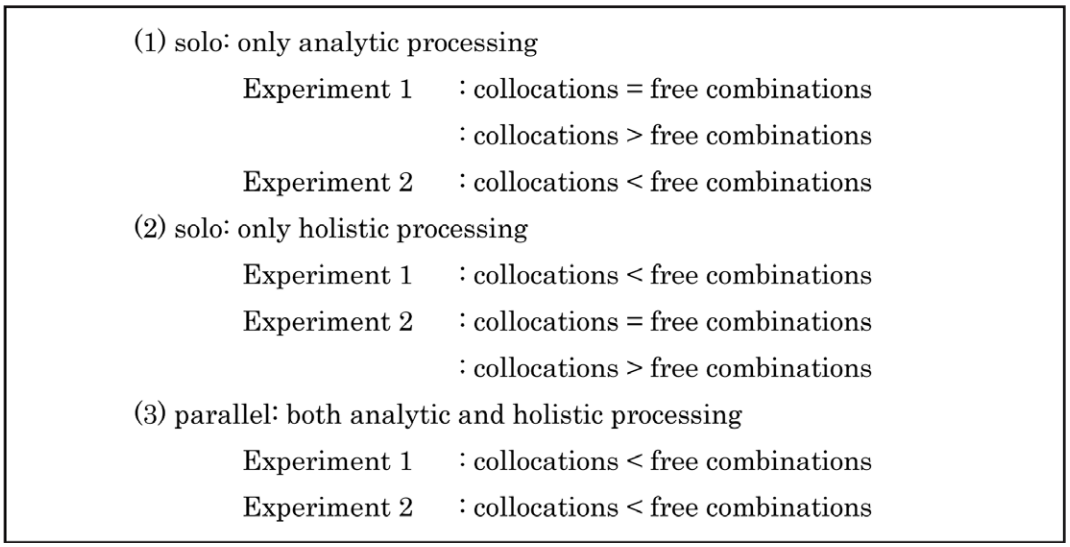

Figure 2: Model expectation for Experiments 1 and 2.
Note. Slower > faster, faster < slower, same = same.

hurt my nose (free combination) was composed to compare the reaction times. If the reaction times for the collocations and the free combinations were processed at the same speed, it was assumed that the collocations were processed in the same way as the free combinations in which an analytic process is operated. However, if the collocations were processed faster than the free combinations, it was assumed that the collocations were being processed holistically (as see in section 1.2). As the stimuli were counterbalanced, the participants reacted to either a collocation or the corresponding free combination.

Experiment 2 employed a priming paradigm and a lexical decision task. After a collocation or a free combination was displayed as the prime, a word associated with the single word that constituted a part of the collocation was shown as the target. Each target was the same word between the collocation and the comparative free combination (e.g., prime 1: *blow my nose*, target 1: *wind* vs. prime 2: *hurt my nose*, target 2: *wind*). Because the targets were the same words, the reaction times in Experiment 2 were expected to be processed at the same speed if the single word in the phrases was not activated. On the other hand, if the reaction times were different in the experiment, a single word in the phrases was activated and influenced the processing speed of the target. That is, a single word in a collocation was accessed when the meaning of the collocation was retrieved. Because the stimuli were counterbalanced, the participants did not react to the same target words.

Based on the expectation outlined in **Figure 2**, the general processing of collocation was analyzed. After analyzing the general processing, the way of processing for each experimental collocation item was examined.

4. Experiment 1

4.1 Method

4.1.1 Participants

Thirty American English NSs (13 female, 17 male) and 30 Japanese ESL learners (22 female, 8 male) participated in Experiment 1, all of who were right-handed. All NSs had at least a high school diploma, and all Japanese ESL (J-ESL) learners were university students or graduate students.[2] All learners scored more than 730 on the Test of English as International Communication (TOEIC). **Table 2** summarizes the participant information.

Table 2: Participant information.

	N	mean age	min. TOEIC score	mean TOEIC score
E(A)-NS	30	27.3	n.a.	n.a.
E(J)-SLL	30	25.7	730	822.4

Note. E(A)-NS stands for native speakers of American English; E(J)-SLL stands for Japanese ESL learners.

4.1.2 Materials

This study extracted verb + noun combinations because, as stated in Hill, Lewis, and Lewis (2000), "The single most important kind are verb + noun collocations which represent the standard, first-choice way of expressing certain concepts" (p. 99). Several steps were taken to extract the experimental collocation items. Firstly, verb + noun combinations were extracted from the American National Corpus (first release), which contains 10 million words, and tagged using the Apple Pie Parser (Sekine, 1996).[3] Then, the G-scores for the verb + noun combinations were computed to judge the collocational strength, from which the verb + noun combinations with higher G-scores were extracted (Matsuno, 2011). To determine the most common expressions for the selected verb + noun combinations, a questionnaire was then conducted with two American English NSs, a sample of which is shown in **Figure 3**.[4] In the next step, the verb + noun pair ranked as the most common by the NSs was extracted, and finally, the verb + noun collocations that could possibly construct meaningful free combinations by a change in verb were extracted.

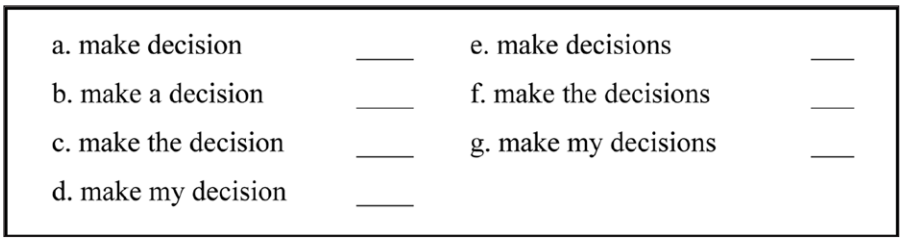

Figure 3: Questionnaire items for identifying the most common expressions.

In order to develop the free combinations, with the aim to extract verbs that were processed within the same reaction time as those in the collocations, using the MRC Psycholinguistic Database, the numbers of letters, phonemes, and syllables were controlled. Then, the free combinations were constructed by combining the verbs with the same noun phrases in corresponding collocations. To confirm that the reaction times for the verbs in the collocations and the reaction times for the verbs in the free combinations were actually the same, a lexical decision task was conducted on the verbs in collocation and those of free combination (confirmation test 1). **Table 3** shows the participant information for confirmation test 1.[4] It was confirmed that the NSs [t_1 = 0.78, p = 0.48; t_2 = 0.97, p = 0.36] and the J-ESL learners [t_1 = –0.91, p = 0.36; t_2 = –1.68, p = 0.13] reacted to the verbs in the collocations in the same time as for the verbs in the free combinations. The number of the items in Experiment 1 is shown in **Table 4**. In Experiment 1, participants selected experimental items as *yes* and dummy items as *no* (Appendix 1).

To make sure the extracted verb + noun phrases were familiar expressions, a questionnaire was conducted on 15 American NSs who were asked to assess the phrases on a five-level scale, from 1 (not at all familiar) to 5 (very familiar).[4] **Table 5** shows the mean familiarity value for the collocations and free combinations in the experiment.

The Wilcoxon signed-rank test found that the NSs felt that the collocations extracted for this study were significantly more familiar than the free combinations [Z_1 = 8.13, p < 0.01; Z_2 = 4.67, p < 0.01].

Table 3: Participant information for confirmation test 1.

	N	mean age	min. TOEIC score	mean TOEIC score
E(A)-NS	10	22.6	n.a.	n.a.
E(J)-SLL	10	29.3	730	838.0

Table 4: Items in Experiment 1.

items	*N*	dummy items	*N*
collocation	51	meaningless verb +noun	51
meaningful free combination	51		
total	102		51

Table 5: Results of the familiarity questionnaire for the experimental items.

	collocations	free combinations
mean familiarity value	4.44	2.85

4.1.3 Procedure

Before starting Experiment 1, each participant practiced with dummy experiments to become familiar with the experimental procedure. Participants were instructed to react as quickly as possible. The stimuli in Experiment 1 were counterbalanced and randomly displayed. In Experiment 1, a fixation string + was displayed in the center of the computer screen for 1000 ms, and then an experimental item (a collocation, a free combination, or a meaningless verb + noun) appeared in the same position. Reaction times of less than 300 ms or more than 3000 ms were classified as errors, and reaction times that exceeded mean value + 2.5 SD or mean value – 2.5 SD were replaced with border values. A t-test was conducted to analyze whether the reaction times to the collocations were significantly different from those of the free combinations.

4.2 Results and discussion

4.2.1 General processing of collocations

Table 6 shows the results for the mean reaction times in Experiment 1. The NS reaction times for the collocations were significantly faster than for the free combinations [$t_1(29)$ = –9.25, p < 0.01; $t_2(50)$ = –18.50, p < 0.01], and the result suggests that NSs accessed the memorized prefabricated units when they processed collocations.

However, J-ESL learners misjudged a greater number of collocations as meaningless word combinations. The number of misjudgments for the learners is presented in **Table 7**. If the collocations had been memorized, the J-ESL learners would have been able to judge these phrases correctly; therefore, it could be surmised that the phrases in which there were high misjudgment rates were processed analytically. **Table 8** shows the reaction times to the collocations with less than three errors and the reaction times for the corresponding free combinations. The J-ESL learner reaction times to the collocations were significantly faster than for the free combinations [$t_1(29)$ = –6.817, p < 0.01; $t_2(35)$ = –8.023, p < 0.01]. The results shown in **Table 8** confirmed that the J-ESL learners, as well as the NSs, had prefabricated patterns and were therefore able to process the collocations as a unit.

Table 6: E(A)-NS mean reaction times in Experiment 1.

	subject analysis		item analysis	
	collocation (*n* = 30)	**free combination (*n* = 30)**	**collocation (*n* = 51)**	**free combination (*n* = 51)**
E(A)-NS	975.04 (134.70)	1437.90 (222.16)	974.25 (153.96)	1429.16 (173.76)

Note. Time units are in milliseconds; standard deviations are in parentheses.

Table 7: The number of misjudgments for the J-ESL learners.

number of misjudgments	**collocations (*n* = 51)**
0	catch the train, close my eyes, cross the street, cut costs, drive my car, fail the test, fill the gap, give a speech, have an idea, launch a campaign, make a mistake, miss the chance, pack a bag, pay attention, play music, ride a bike, ring the bell, satisfy the demand, sing a song, smoke a cigarette, solve the problem, spend time, take medicine, watch TV, wear a hat
1	answer the phone, brush my teeth, commit a crime, lose weight, meet the standards, open an account, swing a bat
2	leak information, put pressure, snap my fingers, win an award
3	grow my hair, lend my support, row the boat, run the risk, send troops
4	blow my nose, call the election, serve the purpose, spoil the fun
5	drop a hint, carry a penalty, leave an impression
6	shoot the video, strike a pose
7	n.a.
8	mow the lawn

Table 8: E(J)-SLL mean reaction times in Experiment 1.

	subject analysis		item analysis	
	collocation (*n* = 30)	**free combination (*n* = 30)**	**collocation (*n* = 36)**	**free combination (*n* = 36)**
E(J)-SLL	1351.88 (202.77)	1789.31 (279.63)	1367.77 (278.55)	1770.23 (265.01)

Note. Time units are in milliseconds; standard deviations are in parentheses.

4.2.2 Processing of each collocation

The NSs processed most of the collocational items faster than the free combinations, as shown in section 4.2.1. However, the three word combinations *call* + *election* [$t = 3.374$, $p = 0.849$], *carry* + *penalty* [$t = 1.499$, $p = 0.151$], and *serve* + *purpose* [$t = 0.480$, $p = 0.637$] were not processed significantly faster than the free combinations. Therefore, it is reasonable to assume that these phrases were processed analytically.

The J-ESL learner did not process the following word combinations significantly faster than the free combinations, even though these phrases were judged correctly: *cross* + *street* [$t = 3.927$, $p = 0.203$], *fail* + *test* [$t = 1.954$, $p = .066$], *fill* + *gap* [$t = 1.327$, $p = 0.201$], *give* + *speech* [$t = 1.455$, $p = 0.163$], *launch* + *campaign* [$t = 1.680$, $p = 0.110$], *leak* + *information* [$t = 0.565$, $p = 0.579$], *meet* + *standard* [$t = -0.189$, $p = 0.852$], *put* + *pressure* [$t = -0.729$, $p = 0.475$], *satisfy* + *demand* [$t = 1.144$, $p = 0.268$], *snap* + *finger* [$t = -1.265$, $p = 0.222$], *swing* + *bat* [$t = -1.451$, $p = 0.164$], *wear* + *hat* [$t = 1.956$, $p = 0.066$], and *win* + *award* [$t = -0.046$, $p = 0.964$]. Therefore, in addition to the collocational items that had high misjudgment rates, these phrases appear to have been processed analytically by the J-ESL learners in this study. These results support the claim that learners utilize less prefabricated patterns than NSs (see section 1.3) and that they do not deal with collocations with less processing load than free combinations as NSs do.

5. Experiment 2

5.1 Method

5.1.1 Participants

The same participants in Experiment 1 took part in Experiment 2. The experimental items were counterbalanced, and the participants did not see the same stimuli in Experiment 1 as in Experiment 2.

5.1.2 Materials

The potential collocations and free combinations used as prime items were identical in Experiment 1. In order to develop the targets, words associated with the single words that constituted a part of the collocation were researched.[5] First, the *Edinburgh Associative Thesaurus* was consulted for the NS experiment, after which a questionnaire on the associated word was conducted for the learner experiment. **Table 9** shows the participant information for the questionnaire.[4]

To confirm whether the target words were actually associated with the verbs in the collocations, a lexical decision task was conducted (confirmation test 2). **Figure 4** summarizes confirmation test 2. **Table 10** shows the participant information for confirmation test 2.[4]

Among the 51 potential items, 24 prime collocations were selected that were able to be extracted for use as experimental items following the above steps, and NSs [t_1 = 5.20, $p < 0.01$; t_2 = 4.46, $p < 0.01$] and J-ESL learners [t_1 = 2.63, $p < 0.05$; t_2 = 4.46, $p < 0.01$] processed the target under the collocational condition (=a prime) faster than the free combination condition (=another prime). The number of items used in Experiment 2 is shown in **Table 11** (Appendix 2).

Table 9: Participant information for a questionnaire on the associated word.

	N	mean age	min. TOEIC score	mean TOEIC score
E(J)-SLL	5	27	730	869.0

Table 10: Participant information for confirmation test 2.

	N	mean age	min. TOEIC score	mean TOEIC score
E(A)-NS	10	24.1	n.a.	n.a.
E(J)-SLL	10	28.2	730	840.5

5.1.3 Procedure

Before starting Experiment 2, each participant practiced with dummy experiments to become familiar with the experimental procedure. Participants were instructed to react as quickly as possible. The stimuli were counterbalanced and randomly displayed. In Experiment 2, first, a fixation string + was displayed in the center of the computer screen for 1000 ms, after which a prime (a verb + noun phrase) appeared in the same position for 1000 ms for the NSs and 1500 ms for the J-ESL learners. Subsequently, a fixation string of # was displayed, with the ISI being 300 ms for the NSs and 500 ms for the J-ESL learners, and the stimulus-onset asynchrony (SOA) being 1300 ms for the NSs and 2000 ms for the J-ESL learners. Then, a target (= a string of letters) was displayed. Reaction times of less than 200 ms or more than 2000 ms were seen as errors, and reaction times that exceeded mean value + 2.5 SD or mean value – 2.5 SD were replaced with border values. A t-test was conducted to analyze whether the reaction times significantly differed for the target words because of the prime (the collocation or the free combination).

5.2 Results and discussion

5.2.1 General processing of collocations

The results of the mean reaction times in Experiment 2 are presented in **Table 12**. NS reaction times to targets after seeing the collocational primes were significantly faster than that for the free combinations [$t_1(29) = -4.224$, $p < 0.01$; $t_2(23) = -6.533$, $p < 0.01$]. These results show that the NSs accessed the single words in collocations. In contrast, as shown in **Table 13**, the J-ESL learners did not react to targets any faster after seeing the collocational

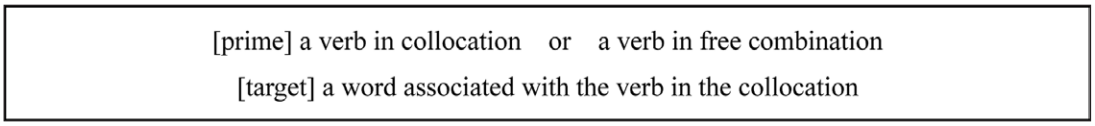

Figure 4: Summary of confirmation test 2.

Table 11: Items in Experiment 2.

		response	prime: collocation	prime: free combination	total
target	items	yes	words associated the single word in collocations: 24	24	48
	dummy items	yes	words not associated the single word in collocations: 24	24	48
		no	non-words: 24	24	48
	total		72	72	144

Table 12: E(A)-NS mean reaction times in Experiment 2.

	subject analysis		item analysis	
	collocation (*n* = 30)	**free combination (*n* = 30)**	**collocation (*n* = 24)**	**free combination (*n* = 24)**
E(A)-NS	578.44 (56.42)	683.11 (120.50)	579.15 (52.23)	684.19 (77.14)

Note. Time units are in milliseconds; standard deviations are in parentheses.

Table 13: E(J)-SLL mean reaction times in Experiment 2.

	subject analysis		item analysis	
	collocation (*n* = 30)	**free combination (*n* = 30)**	**collocation (*n* = 9)**	**free combination (*n* = 9)**
E(J)-SLL	659.84 (120.94)	658.68 (142.50)	667.67 (113.75)	660.69 (69.60)

Note. Time units are in milliseconds; standard deviations are in parentheses.

primes than for the free combinations [$t_1(29) = -0.213$, $p = 0.833$; $t_2(8) = -0.220$, $p = 0.831$].

In the light of **Figure 2**, the results from Experiments 1 and 2 indicated that the NSs in this study generally processed collocations in parallel – that is, both analytically and holistically – whereas the J-ESL learners in this study processed the collocations either analytically or holistically, but not in parallel.

5.2.2 Processing of each collocation

In Experiment 2, the NSs did not process the target words associated with the single word in the following collocations significantly faster than for the free combinations: *answer* + *phone* [$t = -0.81$, $p = 0.936$], *blow* + *nose* [$t = 0.361$, $p = 0.722$], *cut* + *cost* [$t = -0.188$, $p = 0.853$], *leak* + *information* [$t = 1.686$, $p = 0.109$], *lend* + *support* [$t = 0.627$, $p = 0.538$], *lose* + *weight* [$t = 1.642$, $p = 0.118$], *make* + *mistake* [$t = 0.586$, $p = 0.565$], *meet* + *standard* [$t = 1.598$, $p = 0.127$], *play* + *music* [$t = 0.523$, $p = 0.607$], *put* + *pressure* [$t = 0.762$, $p = 0.456$], and *run* + *risk* [$t = 0.652$, $p = 0.522$]. When the above collocations were processed, it was assumed that the meaning of each word was not going to be activated. That is, the results from sections 4.1.2 and 5.1.2 suggest that the NSs in this study processed most of the collocations in parallel, but some kinds of collocations were solely processed. The J-ESL learners did not process the target words associated with the single word in the collocations significantly faster than for the free combinations. In other words, when the memorized collocations of *answer* + *phone* [$t = -1.511$, $p = 0.148$], *catch* + *train* [$t = 1.560$, $p = 0.136$], *cut* + *cost* [$t = -0.551$, $p = 0.588$], *lose* + *weight* [$t = -1.329$, $p = 0.200$], *make* + *mistake* [$t = -1.867$, $p = 0.078$], *open* + *account* [$t = .27$, $p = 0.979$], *pay* + *attention* [$t = -0.989$, $p = 0.336$], *play* + *music* [$t = 0.523$, $p = 0.607$], and *spend* + *time* [$t = 1.534$, $p = 0.142$] were processed, the meaning of each word seems not to be activated.

6. Questionnaire Research on Learning Experience

6.1 Method

6.1.1 Participants

Questionnaire research was conducted on the J-ESL learners who participated in Experiments 1 and 2.

6.1.2 Materials

The collocations and free combinations were identical in Experiment 1.

6.1.3 Procedure

The participants completed a questionnaire regarding their learning experiences with the collocations and free combinations, in which they rated the phrases on a scale from 1 (I have not learned the expression at all) to 5 (I definitely learned the expression). To analyze the results, the collocations were categorized into holistic processing and analytic processing based on the results of Experiment 1 conducted on J-ESL learners (see section 4.2), and then mean, median, and minimum and maximum values of all the holistic processing collocations and those of analytic processing collocations were calculated (the free combinations were listed on the questionnaire as dummy items and were not analyzed in this study). In order to examine whether the learning experience on the memorized phrases was significantly different than that of non-memorized phrases, the questionnaire results were analyzed using the Mann-Whitney U test.

6.2 Results and discussion

6.2.1 Learning experience and collocations

Table 14 gives the mean and median values for all collocational items, which were categorized based on processing types. **Table 14** also shows the minimum and maximum mean values. **Table 15** shows the mean values for the learning experiences for each memorized collocation. Collocations constituted using a different word than in their L1, such as *take* + *medicine*

(*kusuri*/medicine *o nomu*/drink) and *make* + *mistake* (*machigai*/mistake *o suru*/do), are generally memorized by J-ESL learners. If J-ESL learners learn the expressions, the prefabricated patterns can be memorized even though the L2 collocations may be incongruent with those of their L1. The mean values for the collocations that were not memorized are shown in **Table 16**. These are the collocations that were analytically processed by the learners. The word combination *leak* + *information*, which had not been learned, was congruent with Japanese L1 (*jouhou*/information *o morasu*/leak), but *leak* + *information* was not memorized as a prefabricated pattern.

The results from the Mann-Whitney U test indicated that the value of the memorized collocations was significantly higher than for the non-memorized collocations [$U = 39.50$, $p < 0.01$]. Therefore, it could be surmised that the word combinations memorized by the J-ESL learners were mostly expressions whose patterns they had explicitly learned. Because most J-ESL learners have limited exposure to English input, they have fewer opportunities to learn the expressions inductively, which is why even advanced J-ESL learners seem to learn only a limited number of prefabricated patterns and why many memorize fewer prefabricated patterns than NSs.

Table 14: Learning experience for J-ESL learners.

collocational processing	*M*	*Mdn*	*Min*	*Max*
holistic	3.95	4.08	3.03	4.55
analytic	3.10	2.84	2.16	4.16

Table 15: Mean values for memorized collocations.

less than 3.0		from 3.0 to 4.0		more than 4.0	
collocations	***M***	**collocations**	***M***	**collocations**	***M***
		pack + *bag*	3.03	*smoke* + *cigarette*	4.00
		cut + *cost*	3.10	*have* + *idea*	4.03
		take + *medicine*	3.48	*pay* + *attention*	4.06
		answer + *phone*	3.55	*play* + *music*	4.06
		miss + *chance*	3.55	*lose* + *weight*	4.10
		open + *account*	3.55	*drive* + *car*	4.13
		ring + *bell*	3.90	*ride* + *bike*	4.13
				brush + *teeth*	4.16
				catch + *train*	4.16
				close + *eyes*	4.16
				solve + *problem*	4.23
				spend + *time*	4.26
				watch + *TV*	4.35
				sing + *song*	4.39
				make + *mistake*	4.55

Table 16: Mean values for the collocations not memorized.

less than 3.0		from 3.0 to 4.0		more than 4.0	
collocations	***M***	**collocations**	***M***	**collocations**	***M***
leak + *information*	2.16	*fail* + *test*	3.61	*cross* + *street*	4.16
launch + *campaign*	2.39	*win* + *award*	3.84		
put + *pressure*	2.52	*wear* + *hat*	3.87		
swing + *bat*	2.71				
give + *speech*	3.74				
meet + *standard*	2.74				
satisfy + *demand*	2.77				
snap + *finger*	2.84				
fill + *gap*	2.93				

7. General Discussion

The results from Experiments 1 and 2 indicated that the NSs generally processed collocations in parallel – that is, both analytically and holistically—whereas the high-proficiency J-ESL learners processed the collocations either analytically or holistically, but not in parallel. This suggests that the NS collocational processing may differ from J-ESL learners even if the learners have acquired the ready-made expressions. This may be because it was difficult for the J-ESL learners to deal with several simultaneous processes. Because they did not retrieve the word and/or the grammatical and prefabricated pattern information at the same time, they were prevented from attaining fluent production and understanding and were therefore unable to smoothly manipulate language items such as the syntactic operations involved with semi-fixed strings and spoofs of the lexical word combinations. As an example, let us suppose that J-ESL learners memorized the prefabricated patterns *to make a long story short*. When the J-ESL learners intensify the word *long* and insert a word such as *very*, *extremely*, or *really* (e.g., *to make a very/extremely/really long story short*), the processing load is more complex, and they take longer to produce the expression. Without acquiring parallel processing, it would be more difficult to use a foreign language flexibly.

8. Further Research

This study has some limitations as well as possible extensions. First, further experimental items need to be researched because the number of experimental items in the present study was insufficient to come to firm conclusions about the processing of collocations (e.g., J-ESL learners may employ parallel processing for some collocations not dealt with in this study). The different grammar structures within the collocations such as subject + verb also need to be further explored, and additional experimental items with different attributes (e.g., frequency, familiarity, decomposability, and syntactic frozenness) could be examined to determine whether the attributes of a collocation influence mental processing. Moreover, collocations and other multi-word units could be examined to see whether the suggestions regarding parallel processing can be applied to other groups.

A future study could also examine whether the duration of the SOA affected the results in Experiment 2. Under diverse SOA durations, there is a possibility that the results may be different from those in the present study, and such research could elucidate the timing and chronological order in which the language information is retrieved—that is, the time taken to access prefabricated patterns may not be uniform under different conditions.

Further research could compare how learners process collocations in their native language and while using L2. Even though the same meaning may be shared across both languages, these word combinations may be processed differently. For instance, this study found that *serve* + *purpose* was not prefabricated by the American NSs, however the Japanese word combination "*mokuteki o hatasu*" (*mokuteki* = purpose, *hatasu* = serve) may be memorized by Japanese NSs. A future study could reveal how the different types of processing between native language and L2 influence learner performance.

9. Conclusion

This study examined whether NSs and J-ESL learners used parallel processing to access prefabricated patterns and each single word in the pattern when retrieving collocations. Two experiments were conducted involving 30 NSs and 30 highly proficient J-ESL learners and a questionnaire was conducted on the J-ESL participants. It was found that (1) the NSs generally processed collocations in parallel, but some kinds of collocations were solely processed, and that (2) the J-ESL learners solely processed most collocations and utilized fewer prefabricated patterns than the NSs. The results suggest that it may be challenging for learners to simultaneously deal with several processes.

Additional Files

The Additional files for this article can be found as follows:

- **Appendix 1.** Items responded to with Yes in Experiment 1. DOI: https://doi.org/10.22599/jesla.17.s1
- **Appendix 2.** Items responded to with Yes in Experiment 2. DOI: https://doi.org/10.22599/jesla.17.s2

Notes

This paper is based on and progressed from the author's dissertation (Matsuno, 2013).

[1] Yamashita (2014) revealed that the way of instruction affects the reaction time. This study instructed the participants to judge whether the meaning of a phrase makes sense (possible to do or exist in reality). Future research must ascertain whether the results differ depending on the instruction.

[2] Because all NSs had at least a high school diploma, this study assumed that the NS participants have enough language skills to react to the collocations. However, in future research it will probably be required to more rigorously control the characteristics of NS participants.

[3] The annotated corpus was manually checked and corrected.

[4] The participants in confirmation tests (sections 4.1.2 and 5.1.2) were different from those in Experiments 1 and 2, so as to ensure that the participants in experiments had not previously been exposed to the same words, which could result in accelerated reaction times. This study employed statistics on the results in confirmation tests, whose participants (sample 1) are assumed to be from the same group (statistic population) as the participants in Experiments 1 and 2 (sample 2), and are generalized the results to the sample 2. This is only an assumption, so in a future study, it may be required to improve the experimental design.

[5] The results of the questionnaire wherein the participants (three American NSs and three advanced J-ESL learners) answered with the words that were associated with the shown collocations were also used as references. When the words associated with the shown collocations and the words associated with the

verbs in collocations were the same, the collocations were excluded from the experimental items.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Number 15K16795. I appreciate the valuable comments from reviewers and the audience at the EURO-SLA conference. I also thank my professors at Nagoya University for the helpful comments they gave, including advice regarding the programming language Perl. I am grateful to every person from whom I received comments.

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How to cite this article: Matsuno, K. (2017). Processing collocations: Do native speakers and second language learners simultaneously access prefabricated patterns and each single word? *Journal of the European Second Language Association*, 1(1), 61–72, DOI: https://doi.org/10.22599/jesla.17

Submitted: 16 January 2017 **Accepted:** 30 June 2017 **Published:** 01 August 2017

JESLA *Journal of the European Second Language Association* is a peer-reviewed open access journal published by White Rose University Press.

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