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The Activations of Relational Structures in Processing Second Language Noun-noun Compound*

Junkyu Lee**
(Hankuk University of Foreign Studies)

Lee, Junkyu. 2011. The Activations of Relational Structures in Processing Second Language Noun-noun Compound. *Linguistic Research* 28(1), 143-157. A theoretically interesting aspect of noun-noun compounds is how two nouns in the compounds are conceptually combined to be interpreted. Along this line of semantic interpretation, previous first research found a relation priming that the processing of a noun-noun compound is facilitated by previous exposure to another compound particularly when the two compounds share the same first constituent and the same semantic relation (Gagné & Shoben 1997). However, it is controversial whether the relation priming emerges even when two compounds (e.g., orange juice – chocolate cake) have only the same semantic relations but not share a constituent (Estes, 2003; Gagné, Spalding, & Ji, 2005). In order to expand research base of compound processing, this study investigates whether first (L1) and second language (L2) speakers demonstrate relation priming particularly when two compounds have the same relations, yet do not have any identical constituent. In an online lexical sense decision task, an L1 and an L2 group were asked to judge whether a series of compounds had a sensible interpretation. Results showed that neither L1 nor L2 speakers did yield the effect of relation priming, suggesting that sharing the same semantic relations may not be a sufficient condition to observe the activations of relational structures of compounds. **(Hankuk University of Foreign Studies)**

Key Words L2 psycholinguistics, second language acquisition, relation priming, the lexicon, noun-noun compounds

1. Introduction

A combination of two nouns in English is known for one of the most productive morphological processes. An intriguing aspect of the compounding in English is how

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** Hankuk University of Foreign Studies (junkyu@hufs.ac.kr)

native speakers interpret noun-noun compounds, which have never encountered, easily and rapidly. The interpretation process is named in the literature as conceptual combination in the sense that two concepts embedded in a noun-noun compound are integrated into a meaningful relation. For example, example, *dining table* refers to a table FOR dining, but not a table IN dining. In other words, conceptual combination is concerned with how to establish appropriate thematic relations between two nouns in interpretative processes of noun-noun compounds.

Along this line, this study aims to expand on the previous research base of conceptual combination by examining a controversial research domain; this study investigates whether the activations of relational structures, which arise to combine two concepts of a noun-noun compound, can be observed even when prime-target pairs do not have the same constituent.

Before preceding this paper, I would narrow down the linguistic targets of this study because there are many types of noun-noun compounds in English. The target of this study is endocentric compounds such as *dining table* which retain the original meanings of each constituent. Thus, compounds have opaque constituents such as strawberry are not the scope of this study.

In what follows, I discuss what is not controversial and what is on debate, in relation to the interpretations of compounds. Then, the main experiment of this study is explained with an emphasis on the comparison between first and second language speakers. And the findings of this paper will be interpreted in conjunction with the previous literature.

2. Literature Review

2.1 A Consensus on Conceptual Combination

In this section, I will illustrate a general consensus about processing noun-noun compounds in English, when looking from a psycholinguistic perspective. An appropriate interpretation of a noun-noun compound such as *coffee cup* requires the establishment of combinations of two nouns in a meaningful relation. From a psycholinguistic perspective, first language (L1) research suggests that the conceptual combination of a noun-noun compound involves two processes: (1) the meaning

activation of each constituent in compounds and (2) the establishment of meaningful relations to combine each constituent (Estes & Glucksberg 2000; Gagné 2002; Gagné & Shoben 1997, 2002; Murphy 1988, 1990; Wisniewski 1996). That is, speakers not only should access to the meanings of each constituent in a noun-noun compound but also should be able to integrate the meanings of the two constituents in a meaningful, thematic relation. Figure 1 illustrates how these two processes take place in real-time.

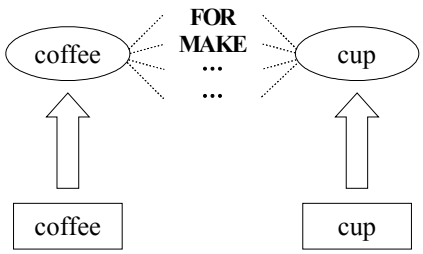

Figure 1. An illustration of conceptual combination of a noun−noun compound

Note that, as shown in Figure 1, conceptual combinations involve the competitions among various relational structures indicated by bold words such as FOR and MAKE. In other words, a constituent in a noun-noun compound can be used in various thematic relations. For example, when used as a modifier (i.e., the first constituent), *coffee* could be combined with various head nouns (i.e., the second constituent), including *coffee table, coffee shop, coffee beans, coffee mug,* and *coffee filter*. Such combinations as *coffee table* and *coffee beans* are not random collections, but rather represent an interpretable relationship between two nouns.

There are at least two related questions to the activations of relational structures in processing noun-noun compounds: (1) how many relations are sufficient to characterize the thematic relations in English noun-noun compounds, and (2) how the activations of relational structures can be observed. As for the first question, linguistic approaches have diverged on the number and characteristics of the relations embedded in compounds. While some scholars have supported the idea of a limited set of thematic relations such as FOR, IN, MAKE, CAUSE (e.g., Levi, 1978), others have favored an unlimited set of semantic relations in interpreting noun-noun compounds in English (Downing 1977, Kay & Zimmer 1976). Despite this divergence on the exact number of thematic relations embedded in compounds, the

existence of thematic relations are generally accepted.

The second related question is a methodological issue: how we can observe the activations of relational structures in conceptual combinations. In L1 psycholinguistics literature, a priming technique, particularly known as relation priming, has been used to claim the activations of relational structures in conceptual combinations. In the relation priming, of interest is to examine whether previous exposure to a noun-noun compound (e.g., orange juice) facilitated the interpretation of a subsequent noun-noun compound (e.g., mango juice) which has the same semantic relation as the previous one (Gagné, 2002; Gagné & Shoben, 1997, 2002). In general, L1 literature suggests that, when comparing two experimental conditions, participants responded faster to prime-target pairs with the same relations (e.g., orange juice – mango juice) than to counterparts with the different relations (e.g., coffee table – metal table). The facilitative effect in the same-relation prime-target pairs has been used for evidence of the existence of relational structures.

2.2 Controversy in L1 Research on Conceptual Combination

In the previous section, the activations of relational structures in conceptual combinations can be tested by observing relation priming (e.g., Gagné, 2002). In this section, I will briefly introduce a major controversy in this research domain.

What researcher has been debated in L1 literature is whether sharing the same constituent is a necessary condition for observing the activation of relational structures in processing noun-noun compounds. That is, researchers have reported mixed results on whether prime-target items in a priming experimental paradigm should share the same constituents in order to observe the activation of relational structures (Estes, 2003; Gagné, Spalding, & Ji, 2005). For example, Gagné (2002) has reported that the relation priming could be found with prime-target pairs containing the same modifier (e.g., student vote – student accusation) but not with priming-target pairs containing the same head (e.g., student vote – employee vote). Furthermore, she observed that the activation of relational structures did not emerge with prime-target pairs only with the same relations but without a constituent (e.g., student vote - government policy). Based on these findings, Gagné (2002) proposed CARIN (competition among relations in nominals) theory for conceptual combination, in which a modifier (i.e., the first noun in English) plays key role in

noun-noun compound processing.

The CARIN theory has been challenged by a finding of Estes (2003). Estes (2003) found that relation priming could be observed with prime-target pairs that do not share any constituent in each pair, arguing that, contrary to the CARIN theory, the relational structures are independent of constituents. Estes (2003)'s findings were a significant challenge to the CARIN theory in the sense that the theory cannot accommodate his findings without modification. However, Gagné, Spalding, and Ji (2005) disproved Estes (2003)'s findings, based on their failure to replicate his findings.

2.3 Evaluations

Aforementioned studies (Gagné & Shoben, 1997; Gagné, 2001; Estes, 2003; Gagné, Spalding, & Ji, 2005) are based on novel compounds, which cannot be found in dictionaries or corpora. An assumption behind this idea is that using familiar compounds such as *apple juice* may not enable us to observe the activations of relational structures. Methodologically, using novel compounds is likely to lead a difficulty in controlling the familiarity and plausibility of the novel compounds, as pointed out by Wisniewski and Murphy (2005). Of empirical interest is whether authentic compounds that can be found in corpora can be used for a priming experiment in order to observe relation priming in L1 speakers.

With respect to second language learners, the use of authentic compounds would be promising in the sense that the compounds may function as novel compounds to second language learners. L2 group has shown the relation priming effect with authentic materials when prime-target pairs shared the same modifier (e.g., Lee, 2010), suggesting that authentic compounds for L2 learners may function similar to novel compounds for L1 learners. Yet, there has been no study to test whether L2 learners show relation priming with prime-target pairs that do not share any constituents.

2.4 Research Questions and Hypotheses

Contributing to the previous research base of conceptual combination, this study aims to examine how L1 and L2 speakers process noun-noun compounds in real

time. Particularly, this study investigates a controversial domain of conceptual combination, in which the empirical validity of relation priming was questioned with prime-target pairs that have the same thematic relation but do not share any constituents. In order to minimize the methodological issue of familiarity and plausibility of novel compounds, this study uses authentic noun-noun compounds, which can be found in a large English corpus containing spoken and written data. Two questions guided the current research.

1. Does a first language (L1) group show the relation priming effect in processing noun-noun compounds when prime-target pairs have the same thematic relations but do not share any constituents?

   Hypothesis 1:

   Relation priming effect in the L1 group. A NS group would respond to targets in the same relation faster than those in the different relation, regardless of the absence of sharing constituents between primes and targets, which indicates that relational structures are an independent of constituents of noun-noun compounds

   Hypothesis 2:

   No relation priming effect in the L1 group. A NS group would not respond to targets in the same relation faster than those in the different relation, when prime-target pairs having the same thematic relation do not have the same constituents, which suggests that relational structures are dependent upon constituents of noun-noun compounds.

2. Does a second language (L2) group show the relation priming effect in processing noun-noun compounds when prime-target pairs have the same thematic relations but do not share any constituents?

Hypothesis 3:

Relation priming effect in the L2 group. Despite the absence of sharing constituents in prime-target pairs, an L2 group would be faster in responding to targets in the same relation than those in the different relation.

Hypothesis 4:

No relation priming effect in the L2 group. In the absence of sharing constituents in prime-target pairs, an L2 group would not be significantly faster in responding to targets in the same relation than those in the different relation.

3. The Current Study

With a special reference to the activation of relational structures, this study is intended to examine online semantic integration patterns of L1 and L2 speakers in processing authentic noun-noun compounds. Specifically, this study investigates whether previous exposure to a familiar compound (e.g., swimming pool) facilitates the processing of a subsequent familiar compound (e.g., tennis shoes), which does not have the same first constituent, yet the same semantic relation as the previous one.

3.1 Method

3.1.1 Participant

32 students at a large mid western University in the U.S participated in this study. An L1 group included 16 native speakers (NSs) of English while an L2 group had 16 Korean speakers of English. The average age of the L1 group was 24.67 whereas that of the L2 group was 27.91.

The members of the L2 group deemed to have an advanced level of English proficiency in the sense that all the participants in the L2 group were undergraduate

and graduate students in the university. In order to maximize the homogeneity of the L2 group with respect to L2 proficiency, all the participants took part in a proficiency test, which was developed to determine students' proficiency level of English in the university. Vocabulary section and the grammar section, both of which were provided in a multiple choice format, were administered to all the L2 participants. All the participants were above 80 percent in the two tests; therefore, their proficiency in English was deemed high at least for vocabulary and grammar.

3.1.2 Instruments

This study used a 2 x 2 experiment design: (1) prime-target and (2) the same relation − the different relation. That is, there were (1) prime-target pairs of the same thematic relations, and (2) corresponding pairs of the different thematic relations. Note that, as illustrated in Table 1, the pairs of prime and target do have the same constituents.

Table 1. The experimental conditions (The 2×2 design)

	Prime	Target
The same relation	herb soap	grape jelly
The different relation	milk butter	leg muscle

Each condition contains 20 items and thus there were 80 experimental items, which can be found in Appendix. All the items were randomly chosen from the COCA corpus (Corpus of Contemporary American English, Davies 2009).[1] Four native speakers of English were asked to determine to which category each item belongs. They were instructed to write down a single predicate that characterize a thematic relation between two nouns in a noun-noun compound. A reference list of predicates with associated examples, as can be seen in Table 2, was provided on the basis of a modified version of Levi (1978)'s taxonomy[2]. They were not only allowed to leave the items unanswered when unsure of the thematic relation, but also

[1] The corpus is the first large and diverse corpus of American English, containing more than 400 million words, which can be freely accessed via http://www.americancorpus.org

[2] The original classification of Levi (1978) included 12 predicates to describe thematic relations, including CAUSE 1 (tear gas), CAUSE 2 (drug deaths), HAVE 1 (apple cake), HAVE 2 (lemon peel), MAKE 1 (silkworm), MAKE 2 (snowball).

permitted to come up with a new predicate such as BY when they cannot find an appropriate predicate.

Table 2. A list of predicates and related examples

Predicates	Examples
CAUSE	tear gas / drug deaths
HAVE	apple cake / lemon peel
MAKE	Silkworm / Snowball
USE	steam iron
BE	soldier ant
IN	field mouse
FOR	horse doctor
FROM	olive oil
ABOUT	price war

The frequency [F (3, 76) = .40, p = .75] and syllables [F (3, 76) = .27, p = .8o] were matched across the four experimental conditions. Also, 80 filler items having non-sensible interpretation (e.g., paper water) were constructed to match the number of correct and incorrect responses.

3.1.3 Procedure

A lexical sense decision task was used in this study (Gagné 2001, 2002; Gagné & Spalding, 2004; Gagné, Spalding, & Ji 2005). The task was constructed by using E-Prime software (Psychological Software Tools, Pittsburgh, PA). Participants were instructed to evaluate whether a noun-noun compound, which were presented without contexts, had a sensible interpretation by pressing a button labeled *yes* or a button labeled *no*.

In the task, participants first encountered a "Ready" and "Please press the spacebar when you are ready." When the participants pressed the spacebar, a fixation point "+" appeared and remained on the screen for 1000 milliseconds. Then, a noun-noun compound appeared on the screen and stayed on the screen until participants pressed a button labeled *yes* or a button labeled *no*. A maximum of 5000 milliseconds was allowed to respond, based on pilot tests with ten L2 learners. The

same cycle was repeated until all the experimental and filler items were presented. The task included a practice session and an actual experimental session. The practice trial included 10 sensible and 10 non-sensible compounds.

3.1.4 Data Analysis

In order to respond to research questions, the average response times and the accuracy scores of the L1 and the L2 groups in the two experimental conditions are analyzed. Particularly, the average response times of the same condition in the two groups were compared with those of the different condition. The generalizability of the analyses was increased by adopting both by-subject (F_1) and by-item (F_2) analyses. Individual data points of the response times, which exceeded above/below two and a half standard deviations, were eliminated from data analysis (2% of the total data points).

3.2 Result

The first question asked whether the L1 group makes relation priming effect when prime-target pairs do not share the same constituent. This question was examined by comparing the mean response times as well as the accuracy scores of the same relation condition with those of the different relation condition in the L1 group.

Two separate within-subject repeated measure analysis of variance (ANOVA) was administered not only with the mean response times of the L1 group in the two conditions as two dependent variables but also with the accuracy scores of the L1 group. The result of the L1 group was given in Table 3.

The result of the response times showed that, when the primes and the targets did not share the same constituent, the L1 group was not faster in responding to the items in the same relation condition than to those in the different relation condition. That is, the 16 millisecond difference in the mean response time was not statistically significant in both by-subject analysis, F_1 (1, 15) = .21, p = .66, and by-item analysis, F_2 (1, 38) = .36, p = .84. Therefore, the L1 group did not demonstrate the relation priming effect.

A comparable pattern was also found with the accuracy scores of the L1 group. A within-subject repeated measure ANOVA demonstrated that the L1 group did not

reveal any significant performance in by-subject analysis, F_1 (1, 15) = 2.77, p = .12, and by-item analysis, F_2 (1, 38) = .04, p = .80.

Table 3. The descriptive statistics of the L1 group

	The Same Relation	The Different Relation
Response times	902.65 (121.69)	918.06 (163.39)
Accuracy scores	.96 (.78)	1.93 (.61)

Note 1. The parenthesis refers to standard deviation.
Note 2. The maximum score of the accuracy was 1.

The second question was concerned with whether relation priming would appear in the L2 group when the stimuli pairs do not share the same constituent. The comparable statistical analysis was conducted to the L2 group with the L1 group. The result of the L2 group was provided in Table 4.

Similar to the L1 group, the L2 group did not yield faster reaction times in responding to the same relation condition than to the different relation times. The 9 millisecond difference in the two conditions was not statistically significant in both by-subject analysis, F_1 (1, 15) = .03, p = .87, and by-item analysis, F_2 (1, 38) = .04, p = .80. Comparably, the accuracy scores did not yield any significant effect, F_1 (1, 15) = .54, p = .47; F_2 (1, 38) = .04, p = .82. Thus, in processing the prime-target pairs in this study, the effect of relation priming was not observed in the L2 group.

Table 4. The descriptive statistics of the L2 group

	The Same Relation	The Different Relation
Response times	1482.23 (292.09)	1493.38 (303.34)
Accuracy scores	.86 (.12)	.88 (.10)

Note 1. The parenthesis refers to standard deviation.
Note 2. The maximum score of the accuracy was 1.

4. Discussion and Conclusion

A general goal of this study is to investigate how first language (L1) and second language (L2) speakers combine the concepts of two nouns embedded in noun-noun

compounds in English in real time. Thus, this study examined whether the response time of target words was facilitated with prime-target pairs of semantically comparable relations, whereas the response time of target words is not primed when presented with prime-target pairs of semantically incomparable relations. Taking into consideration the controversy in the conceptual combination literature, this study used prime-target pairs which do not share any constituent (e.g., Gagné, Spalding, & Ji, 2005).

This study found that neither the L1 group nor the L2 group did yield relation priming when prime-target pairs do not share any constituent. Thus, the findings of this study are in support of the necessity of any shared constituents between primes and targets, in order to observe relation priming in processing noun-noun compounds.

There are some possible interpretations of the findings in this study. First, the findings in this study may indicate that the activations of relational structures during the processes of noun-noun compounds should not be independent of but rather dependent on constituents. Given the findings of this study, a strong version of denying the activation of relational structures can be claimed; no activation of relational structures with prime-target pairs that do not share the same constituent. Alternatively, the findings of this study do not mean that the relational structures are not activated with the stimuli in this study; rather they indicate that the stimuli in this study do not allow us to observe the activation of relational structures that would happen during conceptual combination. Note that the previous L1 and L2 findings (Gagné, 2002; Lee, 2010) found relation priming when prime-target pairs share the same constituent, particularly the same modifier (the first constituent in English). Taken into account the findings of previous studies, it may be fair to claim that the failure to observe relation priming in this study may arise from prime-target pairs in this study.

Also, the stimuli of this study leave open other possible interpretations of the findings. This study used authentic noun-noun compounds that can be found in a large English corpus, which differs from the previous L1 research that used novel noun-noun compounds. Thus, it may be possible for the L1 speakers that the activations of relational structures in processing authentic compounds could be weaker than those in processing novel compounds, suggesting that the activations of relational structures in authentic, lexicalized compounds are difficult to observe in

this priming experiment. However, this interpretation is also questionable, considering the recent findings that even lexicalized compounds appear to undergo an obligatory parsing process (e.g., Fiorentino & Poeppel, 2007). An interesting fact is that the L2 group patterned with the L1 group with the stimuli in this study. The authentic compounds in this study could function as novel ones, given the less developed L2 lexicon. Interestingly, previous L2 research found relation priming with prime-target items sharing the same modifier. Taken together, it may be possible that sharing the same constituent may be a necessary condition to observe relation priming.

To conclude, this study illustrate that relation priming appears not easy to observe prime-target pairs that do not have same constituent. Given this, this study replicates the findings of Gagné, Spalding, & Ji (2005) and adds new information that comes from L2 conceptual combination. Yet, more research needs to be replicated and expanded on this topic, particularly in L2, in order to make better understandings of conceptual combination in processing second languages.

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Junkyu Lee
Graduate school of Education (English Education)
Hankuk University of Foreign Studies
270 Imun-dong, Dongdaemun-gu
Seoul 131-792, Korea
E-mail: junkyu@hufs.ac.kr

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Appendix

	THE SAME RELATION		THE DIFFERENT RELATION	
	Prime	Target	Prime	Target
1	beer mug	business office	adventure movie	combat fatigue
2	cactus thorn	spoon handle	alligator leather	soldier son
3	child actor	male birds	class member	cargo ship
4	clay pottery	grass roof	cough drop	rain coat
5	crime evidence	history chapter	district judge	brass instrument
6	death penalty	problem child	fashion advice	kitchen knife
7	dog leash	gym shoes	golf club	sand dune
8	education convention	soccer magazine	lace pillow	olive sauce
9	fruit juice	fig syrup	lady friend	church hall
10	game manual	storm warning	milk butter	leg muscle
11	gym pants	concert stage	missile attack	bottle opener
12	herb soap	grape jelly	neighbor woman	metal tube
13	lobster claws	committee member	rice wine	genius team
14	machine exercise	sun dial	river boat	fellow worker
15	office furniture	ski boots	river sand	rabbit fur
16	radio dial	bicycle pedal	ship captain	cottage industry
17	sewing machine	fiction writer	snake skin	wall mirror
18	theater seat	hospital pharmacy	sugar alcohol	tea biscuit
19	twin bed	student athlete	trial jury	insurance agency
20	zipper purse	alcohol drink	war protest	steel company