

Processing Nominal Suffixes in Korean: Evidence from Priming Experiments

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Hee-Don Ahn, Duk-Ho An, Jung-Yun Choi, Jong-Bai Hwang, Moongee Jeon, Ji-Hyon Kim. 2011. Processing Nominal Suffixes in Korean: Evidence from Priming Experiments. *Language and Information* 15.1, 1–12. This study investigates morphologically complex nouns in Korean through a series of priming studies. Two experiments examined whether morphological affixes on Korean nouns were decomposed or processed as a whole. Two types of morphological affixes were examined: morpho-syntactic case markers and the plural marker '-tul'. Results showed that priming occurred for the plural marker with SOAs of 80 ms and 160 ms, but no priming occurred for the morpho-syntactic case markers. These results suggest that the morphological processing for these two types of affixes differ. We argue that Korean nouns with the plural suffix are decomposed into the stem and affix, supporting the Decomposition Model (Pinker & Ullman, 2002). We suggest that while plural markers are truly morphological affixes, case markers in Korean are morpho-syntactic, and thus presuppose the existence of other syntactic elements, such as the matrix verb, hence the lack of priming effects. (Konkuk University)

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1. Introduction

Morphology has been playing significant role in language processing in psycholinguistic research in the areas of language comprehension (see Marslen-Wilson, 2007 for extensive review), language production (see Meyer & Belke, 2007 for extensive review), and biology of brain (see Ullman, 2007 for extensive review). This issue has been addressed as to how morphologically complex words are represented in the mental lexicon. This debate took English regular and irregular inflectional morphology, raising fundamental questions about whether rule-like behavior can be explained in terms of: (i) symbolic computation (Clahsen, 1999; Pinker, 1999; Pinker & Ullman, 2002); or (ii) connectionist learning systems, containing no rules and symbols (Rumelhart & McClelland, 1986; Seidenberg & Gonnerman, 2000; McClelland & Patterson, 2002). There is a considerable body of behavioral, brain imaging, and electrophysiological studies concerning morphological processing by native speakers. For example, the status of regular past tense morpheme ‘-ed’ in English and the question of whether morphologically structured representations are required for such forms remains a subject of controversy (see Penke, 2006; Clahsen, 2006 for extensive overview).

Concerning our purposes of this study in particular, many debates on the status of morphologically complex nominals have also been centered on two main models: The so-called Decomposition Model (Pinker & Ullman, 2002) states that in morphological processing, the recognition of an inflected word such as ‘cats’ involves decomposing the word into its stem and its affix, e.g., ‘cat + s’. On the other hand, the so-called Full-listing model (McClelland & Patterson, 2002) claims that every inflected word is recognized as an unanalyzed whole word. Under the Full-listing model ‘cats’ would not be recognized as the word ‘cat’ plus a plural suffix ‘-s’; ‘cats’ would be a single, indecomposable word, just like ‘cat’.

Numerous word recognition studies have also been carried out across languages, employing various experimental technologies, to replicate evidence concerning how morphologically complex words are represented in the lexicon (e.g., Frost, Forster, & Deutsch, 1997; Henderson, 1985, 1989; Laudanna, Cermele, & Caramazza, 1997; Marslen-Wilson, 1999; Sandra & Taft, 1994; Taft, 1985, 1994; Taft & Forster, 1975, 1976). Most of these studies have conducted experiments to investigate whether morphological relations are represented independently of both form (orthographic/phonological) and meaning relationships (e.g., Allen & Badecker, 1999; Drews & Zwitserlood, 1995; Feldman, 1992; 1994; Feldman & Moskovljevic, 1987; Fowler, Napps, & Feldman, 1985; García-Albea et al., 1998). One might argue that morphological relations could be reduced to a convergence of orthographic/phonological and semantic overlapping since morphologically related words not only share a common root or stem but also orthographic/phonological and semantic features. Thus, some current connectionist models have made proposals along these lines (Elman, Bates, Johnson, Karmiloff-Smith, Parisi, & Plunkett, 1996; Rumelhart & McClelland, 1986; Seidenberg & McClelland, 1989; Sereno &

Jongman, 1997). Given these considerations, it seems very crucial for our experimental design to investigate if morphologically related words reveal distinct characteristics from orthographically/phonologically and/or semantically related words.

We will address this issue through the visual word recognition experiments in this paper, using morphologically related nominals in Korean. A set of standard priming procedures will be conducted to show that neither orthographic/phonological nor semantic similarity does not underlie morphological effects. Thus, the experimental results from examining the processing of morphologically complex words in Korean should shed fresh light on the issues related to mental representations and processing mechanisms for morphology.

In this study, in addition to the contrasting predictions of these two models on the morphological processing of Korean nouns and affixes, we further examine facilitation effects with words related by two classes of inflectional suffixes for Korean nominals. The research questions we aim to answer are presented in (1):

- (1) Research questions
 - a. Are morphological affixes on Korean nouns decomposed or processed as a whole?
 - b. Is the processing of (morpho-syntactic) case markers on Korean nouns different from the processing of the (pure morphological) plural marker?
 - c. Do different Stimulus Onset Asynchronies (SOAs) affect the status of the decomposability of nominal suffixes in Korean?

In order to answer these research questions, we conducted two priming experiments examining the morphological processing of two different types of nominal suffixes. The first type of nominal suffix is the case marker type, or the morpho-syntactic type: the nominative case marker ‘-ka’ and the accusative case marker ‘-lul’. The second type of nominal suffix was the plural marker ‘-tul’. The prediction was that these two types of nominal suffixes would show different patterns in morphological processing. The reason behind these predictions is that although the plural marker ‘-tul’ is a purely morphological marker, case markers in Korean, whether nominative or accusative, presuppose the presence of other syntactic elements, whether the matrix verb, or the subject/object of a sentence, hence the term ‘morpho-syntactic’.

2. Experiment 1

2.1 Participants

The participants for the present study were 120 native Korean speakers living in Seoul, Korea. The participants were undergraduate students at a Korean university and were paid for participating in the experiment. The mean age of the participants in Experiment 1 was 22.94 (58 males, 62 females).

2.2 Method

2.2.1 Procedure. The main task for our study was a lexical decision priming task (Foster & Davis, 1984). In a lexical decision task, participants are required to respond as quickly and accurately as possible whether the word presented on the computer screen is a word or a non-word by pressing a "YES" button or a "NO" button on the keyboard. If the reaction time (RT) for the lexical decision for a target item is shorter before a related prime than the RT for an unrelated prime, this is called 'morphological priming'.

In this study, participants were seated in front of a computer and were given instructions for the experiment. They were told to focus on the '+' sign in the center of the computer screen. After the focus point disappeared, they were told that a word would appear in its place. If they thought the word was a correct word in Korean, they were told to press a button on the keyboard for 'yes'. If they thought the word was not an existing word in Korean, they were told to press another button on the keyboard for 'no'.

After 500 ms, the focus point disappeared and the prime word appeared on the screen for 80 ms.¹ After 80 ms, the target word appeared on the screen. It was the target word that they were asked to make a lexical decision on. To prevent the chance of purely orthographic priming, the target word and prime word were presented in different fonts.

In Experiment 1, the participants first were guided through 12 practice items and were given an opportunity to ask questions if they were unsure about the instructions before the actual experiment started. Both the answers to the lexical decision task and the time it took for them to respond were recorded by E-prime software. The entire experiment took about fifteen minutes.

2.2.2 Experimental Design. A between-subjects design was used for this study, with six different conditions depending on the type of prime that was used for this study. The independent variable was the type of noun prime that was used (i.e., condition type) and the dependent variable was the response time (RT) for the lexical decision task. The yes/no answer scores to the lexical decision task were collected for this study in order to examine whether the participants were responding to the items (i.e., target words) correctly. A total of 120 participants were assigned randomly to each of the six conditions (i.e., 20 participants per each condition).

The six experimental conditions according to prime type were as follows: identical, morpho-syntactic, unrelated, semantic, phonological and plural. The test conditions of most interest in this experiment were the morpho-syntactic condition and the plural condition. The morpho-syntactic condition presented a noun plus nominative/accusative case marker as a prime, and the plural condition used a singular noun plus the plural suffix '-tul' as the prime. An example of a prime-target pair in each of the six conditions is presented in Table 1.

¹ The time duration for which the prime word is displayed on the screen is called Stimulus Onset Asynchrony.

[Table 1] Priming conditions

Condition	Prime - Target	
Identical condition	기차 - 기차	kicha ‘train’
Morpho-syntactic condition	기차가 - 기차	kichaka ‘train-Nom’
Unrelated condition	사과 - 기차	sakwa ‘apple’
Semantic condition	여행 - 기차	yehayng ‘travel’
Phonological condition	기차레 - 기차	kichaleyey -> nonword
Plural condition	기차들 - 기차	kichatul ‘train-Pl’

2.2.3 Materials. A total of 180 experimental word prime-target pairs were used; thirty for each of the six conditions. A total of 45 filler prime-target pairs were added to the thirty experiment pairs, thereby producing a total of 75 prime-target pairs in each condition. As the answer to the lexical decision task for all the experimental items was ‘yes’, the filler items were designed so that only eight were real words, and the remaining 37 words were non-words, in order to make the number of ‘yes’ and ‘no’ answers equal. The order in which the test items and fillers presented was randomized for each subject.

2.3 Data Analysis and Results

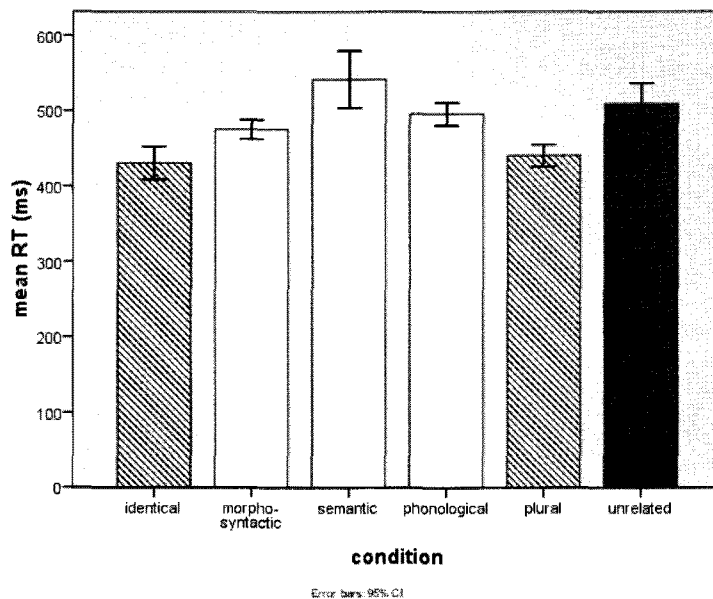
The response times (RTs) to the lexical decision task for each test item by each participant were examined for outliers (i.e., RT scores deviated markedly from other RT scores). RTs deviated from more than 2.5 standard deviation from the mean RT of each condition were excluded from the analysis. A one-way ANOVA (Analysis of Variance) was performed for RT score (i.e., dependent variable) as a function of condition (i.e., independent variable). The mean RTs and SDs (standard deviations) for each condition are shown in Table 2 and Figure 2. The statistical analysis for this study was tested at $\alpha = .05$.

[Table 2] Mean RTs and SDs by condition for Experiment 1

Condition	Mean (ms)	SD	N
Identical condition ^a	430.83	46.67	20
Morpho-syntactic condition	475.48	27.18	20
Unrelated condition	509.31	58.78	20
Semantic condition	541.96	80.72	20
Phonological condition	495.97	33.16	20
Plural condition ^a	440.75	30.70	20
Total	482.50	62.11	120

^a $p < .05$ (baseline: unrelated condition)

The results of the one-way ANOVA showed that there was a significant difference in the RTs for the six conditions ($F(5, 114) = 14.39$, $MSE = 2476.3$, $p < .05$). Post-hoc tests (Tukey HSD) showed that the RTs for the identical condition and the plural condition were significantly shorter than the unrelated baseline condi-



[Figure 1] Mean RTs by condition for Experiment 1

tion ($t = 15.74$, $p < .05$). The RTs for the remaining three conditions (morpho-syntactic, semantic and phonological), however, were not significantly different from the unrelated condition. The difference in RTs between the identical and plural condition was not significant, either ($p = .98$).

2.4 Discussion

The data analysis for Experiment 1 showed that morphological priming occurred for the plural condition, but that priming effects were not found for the morpho-syntactic, i.e., case marker condition. These results suggest that the morphological processing of morpho-syntactic suffixes on Korean nouns is different from the morphological processing of the plural marker '-tul'.

The priming effects we found for the plural condition suggest that the Korean native speakers in this experiment decomposed the plural noun that was presented as the prime into 'singular noun + *tul*'. In other words, the target word (e.g., *kicha* 'train') is recognized faster when it is preceded by a morphologically related inflected word (e.g., *kicha-tul* 'train-Pl'), compared to when it is preceded by an unrelated word (e.g., *sakwa* 'apple'). Note also that priming effects do not occur for orthographically/phonologically related nonce words (e.g., *kichalyey*) and semantically related words (e.g., *yehayng* 'travel'). These results clearly indicate that morphological facilitation cannot be described as the sum of an orthographic/phonological and a semantic effect. Rather, these priming effects provide evidence in support of the Decomposition Model (Pinker & Ullman, 2002)

of morphological processing. In other words, on the assumption that such priming effects result from repeated access to the same morphological root/stem, the results were taken to suggest that the comprehension of morphologically complex words involves decomposition of the plural suffix ‘-tul’ from the root ‘kicha’ at some processing stage.

Note further that there was an absence of priming effects for the morpho-syntactic condition. We suggest that the reason underlying the difference in the morphological processing of these two types of nominal suffixes in Korean lies in the morpho-syntactic nature of the nominative and accusative case markers in Korean. The plural marker ‘-tul’, in Korean, which is a purely morphological marker, behaves much like the English plural marker ‘-s’. However, we claim that case markers in Korean have a morpho-syntactic nature. For example, a noun with the nominative case marker ‘-ka’ in Korean, e.g., ‘*kicha-ka* (train + Nom)’, will be recognized as a potential *subject* of a sentence. This presupposes the existence of other syntactic elements, such as a matrix verb, or possibly an object. Therefore, it is possible that case-marked nouns in Korean are processed differently from plural nouns, which have no case marker.

The results of Experiment 1 suggest that the plural marker is decomposed during morphological processing. However, previous studies have shown that the morphological processing of words may differ along the processing time course (Cunnings & Clahsen, 2007; 2008; Yang, Wang, Chen & Rayner, 2009). Therefore, in order to investigate the possibility that the plural marker and morpho-syntactic case markers in Korean may be processed differently at a longer SOA than the SOA of 80 ms, Experiment 2 was conducted with the same materials at a longer SOA of 160 ms (Rastle, Davis, Marselen-Wilson & Tyler, 2000).

3. Experiment 2

3.1 Participants

All participants, a total of 120 native Korean speakers, for Experiment 2 were undergraduate students at a Korean university who had not participated in Experiment 1. The participants were paid for participating in the experiment. The mean age of the participants in Experiment 2 was 22.27 (63 males, 57 females).

3.2 Method

3.2.1 Procedure. The procedure for Experiment 2 was the same as Experiment 1, except that the prime words for Experiment 2 were presented for 160ms. The entire experiment took about twenty minutes.

3.2.2 Experimental Design. The experimental design for Experiment 2 was the same as Experiment 1. The same six conditions and seventy-five prime-target pairs for each condition were used. The only difference was the SOA. In Experiment 2, the prime was presented for 160 ms, before the target word appeared on the computer screen.

3.2.3 Materials. The test items in Experiment 2 were the same as those in Experiment 1. The order of presentation of the prime-target pairs was randomized for each participant.

3.3 Data Analysis and Results

The data for Experiment 2 was analyzed in the same way as the data in Experiment 1. The response times (RTs) to the lexical decision task were examined for outliers. RTs deviated from more than 2.5 standard deviation from the mean RT of each condition were excluded from the analysis. The remaining data was submitted to a one-way ANOVA with condition as a between-subjects factor. The statistical analysis for this study was tested at $\alpha = .05$. The mean RTs for each condition are shown in Table 3 and Figure 2 (on next page).

[Table 3] Mean RTs and SDs by condition for Experiment 2

Condition	Mean (ms)	SD	N
Identical condition ^a	385.63	26.37	20
Morpho-syntactic condition	468.00	47.89	20
Unrelated condition	498.42	56.82	20
Semantic condition	492.79	44.51	20
Phonological condition	517.36	54.19	20
Plural condition ^a	439.66	43.59	20
Total	466.55	63.34	120

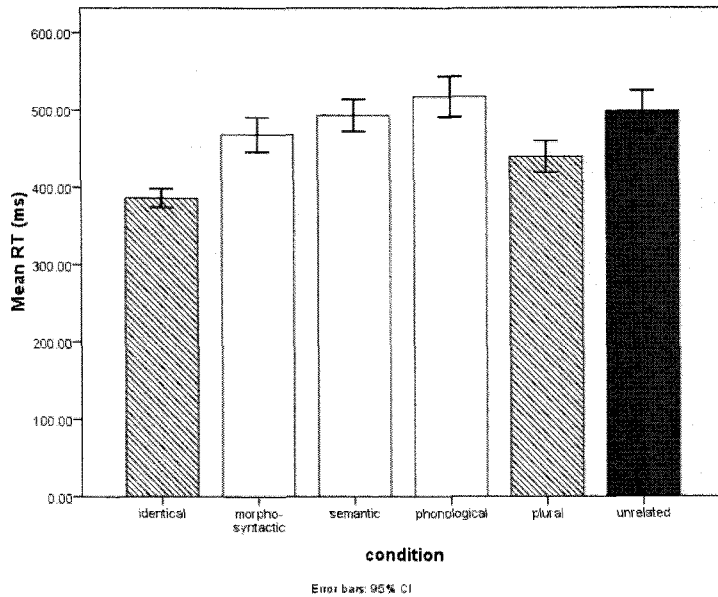
^a $p < .05$ (baseline: unrelated condition)

The results of the one-way ANOVA showed that there was a significant difference in the RTs for the six conditions ($F(5, 114) = 21.11$, $MSE = 2165.9$, $p < .05$). Post-hoc tests (Tukey HSD) showed that the RTs for the identical condition ($p < .05$) and the plural condition ($p < .05$) were significantly shorter than the unrelated baseline condition. The RTs for the remaining three conditions (morpho-syntactic, semantic and phonological), however, were not significantly different from the unrelated condition. The difference in RTs between the identical and plural condition was significant ($p < .05$).

3.4 Discussion

The data analysis for Experiment 2 showed results similar to the results from Experiment 1. The priming effects were found for the plural condition while priming effects do not occur for the orthographically/phonologically related condition and semantically related condition. On a par with Experiment 1, these results on morphological decomposition of inflected forms of plurals in Korean gain substantial support to the 'Words and Rules' theory (Clashen, 1999; Pinker, 1999; Pinker & Ullman, 2002) in distinction to connectionist approaches which deny the existence of decomposable morphological units for processing (Rumelhart & McClelland, 1986; McClelland & Patterson 2002).

Note further that morphological priming occurred for the plural condition, while priming effects were not found for the morpho-syntactic, case marker con-



[Figure 2] Mean RTs by condition for Experiment 2

dition. These results suggest that the increase in SOA from 80 ms to 160 ms does not affect the morphological processing of Korean nominal suffixes and that the morpho-syntactic suffixes on Korean nouns are qualitatively different from the morphological processing of the plural marker '-tul'.

Note, however, that there was a slight difference in the RT analysis for Experiment 2 in that the mean RT for the plural condition was significantly longer than the mean RT for the identical condition ($p=.005$). Thus, the plural condition RTs were longer than the identical condition, but shorter than the unrelated condition. Verissimo & Clahsen (2009) define this type of priming as 'partial priming' and place a distinction from 'full priming', i.e., cases in which there is no difference between the test condition and the identical condition, but a significant difference between the test condition and the unrelated condition. The distinction between these two terms are not universally accepted. However, partial priming at an SOA of 160ms, versus full priming at an SOA of 80 ms suggests it may be that the morphological decomposition of the single noun and plural marker, e.g., '*kicha-ka* (train-Nom)' occurs more strongly at the time course of about 80 ms (Cunnings & Clahsen, 2007; 2008; Yang, Wang, Chen & Rayner, 2009).

The results showing no priming effects for the morpho-syntactic condition replicate the results we obtained for Experiment 1 and provide additional support for our conclusions that nouns with case-markers in Korean are processed in a qualitatively different manner than nouns with purely morphological markers.

4. Conclusion

This study examined the morphological processing of two types of nominal suffixes in Korean: the plural suffix '-tul' and nominative/accusative case markers. The results from two priming experiments showed that morphological priming effects were found for the plural marker '-tul', but no priming effects were found for the morpho-syntactic case markers. These results suggest that morphological affixes on Korean nouns are decomposed during processing.

Our findings support the Decomposition Model (Pinker & Ullman, 2002) of morphological processing. The plural suffix on nouns is decomposed, so that a plural noun will always be morphologically processed as a single noun plus a plural suffix. Moreover, these priming effects cannot be due to phonological or semantic similarity between the prime and target, as the prime/target pairs in the plural condition and morpho-syntactic condition share the same amount of phonological/semantic overlap between the prime and target. Regarding the lack of priming effects for case markers, we suggest that case markers are not purely morphological affixes, but rather morpho-syntactic markers.

In addition, the results of our study also suggest that the decomposition of a plural noun into the singular stem and plural suffix occurs at the time points of both 80 ms and 160 ms in the morphological processing time course. To conclude, we hope that the results of our study provide a good starting point for many future studies on the morphological processing in Korean.

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