Morphological Processing and Some Implications for the Linguistic Theory

Feb 5, 2012
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Issues in Nominal vs. Verbal Suffixes: A Theoretical Overview
Korean is an **agglutinative** language.

**Suffixes**

- **Nominal suffixes**
  - *case markers*: Mary-*ka*  John-*ul*
    - M.-nom J.-acc
  - *plural marker*: haksayng-*tul*
    - student-pl
  - etc.

- **Verbal suffixes**
  - *tense/aspect; force/clause-type*  po-*si-ess-ta/ni/ko*
    - see-hon-past-dec/Q/and
  - *prefinal ending*
Previous proposals in Korean grammar

Chwu, Shi-Kyeng (주시경) (1910), Kim two-young (1916), Lee, Sung-nyung (이숭녕) (1953)

Analyzes nominal and verbal suffixes as independent categories.

Lee, Sung-nyung (이숭녕) (1953)

Treats these suffixes as parts of words.

Choi, Hyen-Bay (최현배) (1937), Hyeong, Kim Seok-duk, Kim Seong-kon ...

Nominal suffixes are independent categories while verbal suffixes are not.

Prefinal endings are considered a kind of derivational affixes, while final endings are inflectional (최현배 1937).
(cf. Ahn et al. 2011)
Usual assumptions

✓ Nominal suffixes (cf. Ahn 1988)
  ▪ Case markers
    Mary-ka
    M.-nom

\[
\begin{array}{c}
\text{XP} \\
\text{NP} & \text{X} & \text{X} = \text{D, K, etc.} \\
\text{Mary} & \text{ka} \\
\end{array}
\]
**Usual assumptions**

- Verbal suffixes (cf. Ahn & Yoon 1989)
  
  John-i   Mary-lul   *ttayli-ess-ta*
  
  J.-nom   M.-acc     hit-past-dec
  
  ‘John hit Mary.’

  *ess = prefinal ending*
  
  *ta = final ending*
Main Issues

What is the nature of the affixation processes?

- the levels at which affixation takes place.

Diagram:

- Lexicon
  - Lexical component
  - Syntactic component
    - PF
    - LF
    - morpho-phonological component
Previous proposals regarding verbal morphology

  - verbs and inflectional affixes are independent syntactic heads.

- Chomsky (1993)
  - verbs enter the structure fully inflected. (Lexicalism)
  - (i.e. verbs and affixes are combined from the start)

- Lasnik (1995)
  - some verbs are fully inflected from the start, others are bare.
Our Assumption

✓ A kind of **hybrid** analysis of suffixation in Korean (cf. Choi 1937)

- Nominal suffixes: Affixation (Merger) at PF

- Verbal suffixes:
  - Prefinal endings: Affixation (Merger) **in the Lexicon**
  - Final endings: Affixation (Merger) **at Narrow Syntax**

♣ We expect these differences to be reflected in the results of our experimental study: **Grammar = Processing**
Evidence for Hybrid Approach
Evidence from Phonology

✓ Differences between nominal and verbal suffixes
    a. 없어 ‘to not exist’
       /eps-e/ \(\rightarrow\) [epse / *ebe]
    b. 값을 ‘price-Acc’
       /kaps-ul/ \(\rightarrow\) [kapsul / kabul]
Production errors are very rare for verbal suffixes, whereas production errors such as omission, misplacement, substitution occur extensively and systematically with nominal affixes in Korean L1 acquisition corpus (S-W Cho 2000).
Evidence from L2 Acquisition

✓ Errors of Nominal suffixes (substitution: Acc ~ Nom)

(1)  a. 나는 수증기 다리미를 있어요. (미국, 초급)
     b. 저는 꽃이 좋아합니다. (일본, 초급)

✓ Errors of Verbal suffixes (omission, misplacement)

(2)  a. 적녁을 먹 후에 비디오 빌리고 봐요. (미국, 초급)
     b. 오후에 친구가 전화를 하겠어요. (필리핀, 초급)

✓ Verbal suffix errors are found only in the beginning levels. By contrast, nominal suffix errors are observed across all levels (J-H Lee 2003).
Evidence from (Nonprimed) Lexical Decision Task

✅ Differences between prefinal and final verbal suffixes

Hwang (2008): the verb stem and the prefinal suffix behave as a unit excluding the final suffix.

Issues in Morphological Processing

Part I: L1 Processing
The mental lexicon of an individual indicates that *person’s knowledge of vocabulary*.
Questions in Morphology?

✓ How morphological knowledge (i.e., knowledge of complex words and of morphological rules) is represented in the human mind?
✓ How morphological knowledge is used in language processing?
Knowledge in a particular domain of human cognition (e.g., morphological knowledge)

- Storage of information
- The ability to compute new information
When people want to use the word *books*, they have two ways to do this:

- (1) They can retrieve the plural form of *book* from our lexical memory (i.e., focusing on storage of information)
- (2) They can create it on line, by adding the plural suffix *–s* to the stem *book* (i.e., focusing on computation)

What determines the choice between these two routes?

Empirical research of such questions help us to get a better understanding of the nature of human cognitive capacities
An Interesting Question

✓ How does people recognize the word *played* in their mind?
Two Ways for Accessing Linguistic Information in “Complex Words”

✓ Computation
  ▪ People first decompose the complex word into its constituent morphemes
  ▪ Then, they retrieve the meaning of these morphemes from the entries in their mental lexicon

✓ Storage
  ▪ Complex words are stored in our mental lexicon
  ▪ So, word recognition is performed by matching perceived words with their corresponding entries in their mental lexicon
Debates on Processing Morphologically Complex Words

 ✓ Decomposition model 
   (Pinker & Ullman, 2002) 
   ▪ Recognition of an inflected word involves decomposing the word into its stem and its suffix

 ✓ Full-listing model 
   (McClelland & Patterson, 2002) 
   ▪ Every inflected word is recognized as a mono-morphemic whole word
the contrast between regular and irregular inflection (Clahsen 1999; Marslen-Wilson and Tyler 1998; Pinker 1999):

- walk-walked vs. bring-brought
- Regular: $V_{past} \rightarrow V_{stem} + d$
- Irregular: $V \quad V$
  
  \[\begin{array}{c}
  \text{bring} \\
  \text{brought}_{past}
  \end{array}\]
Psycholinguistic evidence from experimental results

- **Lexical decision** experiments for **memory** (= stored in the lexicon)
- **Priming** experiments for **symbolic computations** (= morphologically analyzable or decomposable)
Clahsen, Eisenbeiss, and Sonnenstuhl (1997) obtained processing differences between regularly and irregularly inflected word forms in visual lexical decision experiments.

Shorter lexical decision times were found for irregular German participles with a high word-form frequency than for those with a low word-form frequency. For regular participles, however, there was no corresponding word-form frequency effect.

These results suggest that only irregular participles access full-form entries in the mental lexicon.
**Priming tasks**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Prime</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identical Condition</td>
<td>walk</td>
<td>WALK</td>
</tr>
<tr>
<td>Control Condition</td>
<td>smile</td>
<td>WALK</td>
</tr>
<tr>
<td>Regular Condition</td>
<td>walked</td>
<td>WALK</td>
</tr>
<tr>
<td>Irregular Condition</td>
<td>taught</td>
<td>TEACH</td>
</tr>
</tbody>
</table>

--- Phonological or Orthographical? ---

<table>
<thead>
<tr>
<th>Condition</th>
<th>Prime</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular Condition</td>
<td>geöffnet</td>
<td>ÖFFN ‘open’</td>
</tr>
<tr>
<td>Irregular Condition</td>
<td>geschlafen</td>
<td>SCHLAF ‘sleep’</td>
</tr>
</tbody>
</table>
The findings on regular and irregular inflection may show that lexical entries are not simply encoded in terms of phonological (and semantic) properties, but incorporate morphologically structured representations for regulars, and not (or less so) for irregulars.
Processing Suffixes in Korean: Evidence from Priming Experiments
1. To investigate whether nominal and verbal suffixes (final and prefinal endings) are decomposed or processed as a whole

2. To examine the difference between nominal and final verbal suffixes; i.e., to see whether processing timing of nominal/verbal affixes are different: Syntax vs. PF

3. To examine the difference between final and prefinal verbal endings; i.e., to see whether prefinal suffixes pattern with productive derivation suffixes in other languages

4. To investigate whether different methodology (masked priming vs. cross-modal priming) affect the status of decomposability of nominal/verbal suffixes in Korean
Results

1. Nominal and verbal suffixes (final and prefinal endings) are all decomposed in processing
2. No difference between nominal and final verbal suffixes
3. Unlike final verbal endings, prefinal endings exhibit both lexicality effects and priming effects; i.e., prefinal endings are formed in the lexicon but they are registered as separate morphological units
4. Different methodology (masked priming vs. cross-modal priming) does not affect the status of decomposability of nominal/verbal suffixes in Korean
Methodology

✓ Lexical decision (priming) task
  ▪ Masked priming (SOA\(^1\) = 30 ms)
  ▪ Cross-modal priming

✓ Within-subjects design

\(^1\)SOA: Stimulus Onset Asynchrony
Outline of Experiments

✅ Nominal experiments
  - Plural marker ‘-들’
    - 5 conditions (prime type)
  - Nominative marker ‘-가’
    - 3 conditions

✅ Verbal experiments
  - Verbal ending ‘-고’
    - 5 conditions
  - Past marker ‘-었’
    - Regular verbs : 3 conditions
    - Irregular verbs : 3 conditions
Procedure- Priming task

Masked priming

- Mask (500 ms): ###
- Prime word (30 ms): 기차들
- Target word (500 ms): 기차
- Lexical Decision Task: YES or NO
Cross-modal priming

- Fixation point: + (450 ms)
- Auditory target: 기차들
  (50 ms interval)
- Target word (500 ms): 기차

Lexical Decision Task: YES or NO
Within-subjects design
(One-way ANOVA)

- IV (Independent variable):
  - Type of noun form
    - ‘-들’ (5 conditions)
    - ‘-가’ (3 conditions)
  - Type of verb form
    - ‘-고’ (5 conditions)
    - ‘-었’ (3 conditions)

- DV (Dependent variable):
  - Response time (RT)
  - Yes/No answer to lexical decision
Experimental Conditions (Nominal)

✅ Plural marker ‘-들’

- Identical condition: 기차 → 기차
- Morphologically-related condition: 기차들 → 기차
- Unrelated condition: 사과 → 기차
- Phonologically-related condition: 기차례 → 기차
- Semantically-related condition: 여행 → 기차
Experimental Conditions (Nominal)

✓ Nominal case marker ‘-가’

- Identical condition: 기차 → 기차
- Morphologically-related condition: 기차가 → 기차
- Unrelated condition: 사과 → 기차
Experimental Conditions (Verbal)

✓ Verbal ending marker ‘-고’
  ▪ Identical condition: 가다 → 가다
  ▪ Morphologically-related condition: 가고 → 가다
  ▪ Unrelated condition: 사과 → 가다
  ▪ Phonologically-related condition: 가트 → 가다
  ▪ Semantically-related condition: 출발 → 가다
Experimental Conditions (Verbal)

- Verbal past marker ‘-었’ (Regular verbs)
  - Identical condition: 먹다 → 먹다
  - Morphologically-related condition: 먹었다 → 먹다
  - Unrelated condition: 책상 → 먹다
Experimental Conditions (Verbal)

✓ Verbal past marker ‘-었’ (Irregular verbs)
  ▪ Identical condition: 부르다 → 부르다
  ▪ Morphologically-related condition: 불렀다 → 부르다
  ▪ Unrelated condition: 책상 → 부르다
Materials

✓ Nominal experiments (masked / cross-modal)
  - Plural marker ‘-들’ (n = 50/50)
    - 50 prime – target word pairs / 150 filler pairs
  - Nominative marker ‘-가’ (n=30/30)
    - 48 prime – target word pairs / 152 filler pairs

✓ Verbal experiments (masked / cross-modal)
  - Verbal ending ‘-고’ (n=50/50)
    - 50 prime – target word pairs / 150 filler pairs
  - Past marker ‘-었’
    - Regular verbs (n=30/30):
      30 prime – target word pairs / 170 filler pairs
    - Irregular verbs (n=57/45):
      30 prime – target word pairs / 170 filler pairs
Participants

✓ Native Korean speakers (n=80/80) (Konkuk University students)

✓ Nominal experiments (masked / cross-modal)
  ▪ Plural marker ‘-들’ (n = 50/50)
    • Masked: M/F: 33/17, mean age: 25
    • Cross-modal: M/F: 16/24, mean age: 21.8
  ▪ Nominative marker ‘-가’ (n=30/30)
    • Masked: M/F: 20/10, mean age: 24.5
    • Cross-modal: M/F: 18/12, mean age: 23.4
Participants

✓ Native Korean speakers (n=137/125) (Konkuk University students)

✓ Verbal experiments (masked / cross-modal)
  - Verbal ending ‘-고’ (n=50/50)
    • Masked: M/F: 26/24, mean age: 24
    • Cross-modal: M/F: 31/19, mean age: 25.5
  - Past marker ‘-었’
    • Regular verbs (n=30/30)
      - Masked: M/F: 19/11, mean age: 23.5
      - Cross-modal: M/F: 17/13, mean age: 24.4
    • Irregular verbs (n=57/45):
      - Masked: M/F: 28/29, mean age: 23.5
      - Cross-modal: M/F: 27/18, mean age: 24.5
# Types of Priming

<table>
<thead>
<tr>
<th>Type of Priming</th>
<th>Difference between identical and test</th>
<th>Difference between test and unrelated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong/Full Priming</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>(Partial) Priming</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Weak/No Priming</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>No Priming</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
Results: Nominal Suffixes
Results: Plural marker ‘-들’ (masked priming)

* Blue bars represent conditions with RTs significantly different from the unrelated condition (p < .05)
Results: Plural marker ‘-들’ (cross-modal priming)

* Blue bars represent conditions with RTs significantly different from the unrelated condition (p <.05)
Results: Plural marker ‘-들’

✓ Full priming occurred for:
  ▪ Masked priming experiment
  ▪ Cross-modal priming experiment
Results: Nominal case marker ‘-가’ (masked priming)

* Blue bars represent conditions with RTs significantly different from the unrelated condition (p < .05)
Results: Nominal case marker ‘-가’
(cross-modal priming)

* Blue bars represent conditions with RTs significantly different from the unrelated condition (p < .05)
Results: Nominal case marker ‘-가’

✓ Partial priming occurred for:
  ▪ Masked priming experiment
  ▪ Cross-modal priming experiment
The processing of morpho-syntactic markers on Korean nouns is different from the processing of the plural marker

- Nominative/accusative markers on Korean nouns involve syntactic elements
  - Morpho-syntactic processing
    - 기차가: Agent
      Train- NOM
  - Partial priming occurred
The processing of **morpho-syntactic markers** on Korean nouns is different from the processing of the **plural marker**

- Strong/full morphological priming occurs with the **plural marker** only
- Plural markers are decomposed during morphological processing
  - 기차들: 기차 + 들
  - Train-PL
Results: Verbal Suffixes
A Proposed Model of Verbal Suffix in Korean

Mental Lexicon

먹 (mek) verb root
먹었 (mekess) verb root+prefinal ending
있 (ess) prefinal ending
다 (ta) final ending

Syntax

먹었+다 (mekess+ta) verb root+prefinal ending+final ending
먹+다 (mek+ta) verb root+final ending
Hwang’s Study (2008) for Verbal Suffix in Korean

✅ Lexicality effect

- The inflected morphological types yield a word-form frequency effect in unprimed lexical decision, i.e., significantly shorter response times for high-frequency inflected forms than for low-frequency ones.
Hwang’s Study (2008) for Verbal Suffix in Korean
(“Root + Prefinal” Frequency Effect)

1Mean frequency for Verbs (roots + prefinal endings + final endings)

<table>
<thead>
<tr>
<th></th>
<th>root+prefinal frequency</th>
<th>root frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High frequency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(kasita→kasi+ta) ‘to go’</td>
<td>461</td>
<td>4473</td>
</tr>
<tr>
<td><strong>Low frequency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(phasita→phasi+ta) ‘to sell’</td>
<td>3</td>
<td>3817</td>
</tr>
</tbody>
</table>

1based on Sejong corpus (10million-word Korean corpus)
Hwang’s Study (2008) for Verbal Suffix in Korean  
(“Root + Prefinal” Frequency Effect)

1RT (means, SD) for conditions

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>High frequency verbs</td>
<td>445</td>
<td>57</td>
</tr>
<tr>
<td>Low frequency verbs</td>
<td>477</td>
<td>66</td>
</tr>
</tbody>
</table>

\(^1\) t(78)=-2.31, p < .05
**Hwang’s Study (2008) for Verbal Suffix in Korean**

(“Root + Prefinal + Final” Frequency Effect)

1 Mean frequency for Verbs (roots + prefinal endings + final endings)

<table>
<thead>
<tr>
<th></th>
<th>root+prefinal+ final frequency</th>
<th>root frequency</th>
<th>Root+prefinal frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High frequency</strong> Verbs</td>
<td>358</td>
<td>8610</td>
<td>598</td>
</tr>
<tr>
<td>(기다렸다 → 기다렸 + 다)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Low frequency</strong> Verbs</td>
<td>1.2</td>
<td>7128</td>
<td>474</td>
</tr>
<tr>
<td>(불렀건만 → 불렀 + 건만)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 based on Sejong corpus (10million-word Korean corpus)
Hwang’s Study (2008) for Verbal Suffix in Korean
(“Root + Prefinal + Final” Frequency Effect)

1RT (means, SD) for conditions

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
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</tr>
</thead>
<tbody>
<tr>
<td>High frequency verbs</td>
<td>444</td>
<td>32</td>
</tr>
<tr>
<td>Low frequency verbs</td>
<td>490</td>
<td>47</td>
</tr>
</tbody>
</table>

\[ t(50)=-2.2, \ p<.05 \]
Hwang’s study suggests that

- the “verb root + prefinal (먹+었/mek+ess)” form exists in the mental lexicon (root + prefinal frequency effect)
- the “verb root + prefinal + final” is divided into “verb root + prefinal” and “final” (root + prefinal + final frequency effect)
Results: Verbal suffix ‘-고’ (masked priming)

* Blue bars represent conditions with RTs significantly different from the unrelated condition (p < .05)
Results: Verbal suffix ‘-고’ (cross-modal priming)

* Blue bars represent conditions with RTs significantly different from the unrelated condition (p <.05)
Results: Verbal suffix ‘-고’

✓ Full priming occurred for:
  ▪ Masked priming experiment

✓ Partial priming occurred for:
  ▪ Cross-modal priming experiment
Results: Past marker ‘-었’ (masked priming)
Regular verbs

* Blue bars represent conditions with RTs significantly different from the unrelated condition (p < .05)
Results: Past marker ‘-었’ (cross-modal priming)  
Regular verbs

* Blue bars represent conditions with RTs significantly different from the unrelated condition (p < .05)
Results: Past marker ‘-었’ - Regular verbs

✓ Partial priming occurred for:
  § Masked priming experiment

✓ Full priming occurred for:
  § Cross-modal priming experiment
Results: Past marker ‘-었’ (masked priming)
Irregular verbs

* Blue bars represent conditions with RTs significantly different from the unrelated condition (p < .05)
Results: Past marker ‘-었’ (cross-modal priming) Irregular verbs

* Blue bars represent conditions with RTs significantly different from the unrelated condition (p < .05)
Results: Past marker ‘-었’ - Irregular verbs

✓ Full priming occurred for:
  - Masked priming experiment

✓ Partial priming occurred for:
  - Cross-modal priming experiment
Comparison between Nominal and Verbal Markers

<table>
<thead>
<tr>
<th></th>
<th>Masked priming</th>
<th>Cross-modal priming</th>
</tr>
</thead>
</table>
| **Strong / Full Priming** | • Plural marker ‘-들’  
• Verbal suffix ‘-고’  
• Past marker ‘-쓰’  
(irregular verbs) | • Plural marker ‘-들’  
• Past marker ‘-었’  
(regular verbs) |
| **Weak / Partial priming** | • Nominal marker ‘-가’  
• Past marker ‘-었’  
(regular verbs) | • Nominal marker ‘-가’  
• Verbal suffix ‘-고’  
• Past marker ‘-쓰’  
(irregular verbs) |
| **No Priming**       | none           | none                |
Research goals

1. To investigate whether nominal and verbal suffixes (final and prefinal endings) are decomposed or processed as a whole

2. To examine the difference between nominal and final verbal suffixes; i.e., to see whether processing timing of nominal/verbal affixes are different: Syntax vs. PF

3. To examine the difference between final and prefinal verbal endings; i.e., to see whether prefinal suffixes pattern with productive derivation suffixes in other languages

4. To investigate whether different methodology (masked priming vs. cross-modal priming) affect the status of decomposability of nominal/verbal suffixes in Korean
1. Nominal and verbal suffixes (final and prefinal endings) are all decomposed in processing, hence supporting decomposition model

2. No difference between nominal and final verbal suffixes, hence no psycholinguistic evidence for 최현배’s 절충주의

3. Unlike final verbal endings, prefinal endings exhibit both lexicality effects and priming effects; i.e., prefinal endings are formed in the lexicon but they are registered as separate morphological units, partially supporting 황유미 (2008) and 최현배 (1937)

4. Different methodology (masked priming vs. cross-modal priming) does not affect the status of decomposability of nominal/verbal suffixes in Korean
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(2010-2012)

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