Prosodic Structure of Sino-Korean Words*

Eunjoo Han

1. Introduction

This paper is mainly concerned with the /l/-/n/ alternation and the /n/-∅ alternation which apply in Sino-Korean compounds. The analysis of those two phonological phenomena crucially relies on the prosodic structure postulated for Sino-Korean compounds. The presence of a special type of Sino-Korean compounds, i.e. compounds of a free stem plus a bound root, makes it complicated to give an appropriate prosodic characterization of Sino-Korean compounds. It is proposed in this paper that the conflict found between the analysis of the /l/-/n/ alternation and that of the /n/-∅ alternation can be dealt with on the basis of non-uniform prosodic structure which results from ranking structural economy over uniformity (Ito and Mester 1998).

This paper is organized as follows. Section 2 introduces the data on the /n/-∅ alternation and the analysis by Han (1994). Section 3 presents the data regarding the /l/-/n/ alternation and also shows that the prosodic structure posited for the /n/-∅ alternation cannot give a correct account for the /l/-/n/ alternation. In Section 4, the idea of the minimal word structure suggested by Ito and Mester (1998) is summarized and a new prosodic structure is proposed based on the minimal word structure in Section 5. Section 6 considers a possible alternative account and finally Section 7 concludes the paper.

2. /n/-∅ Alternation in Korean

Korean has a phonological phenomenon of so-called /n/-insertion. /n/-insertion is responsible for the /n/-∅ alternation in the examples in (1).[1]

(1) a. Compounds

tʰæyaŋ+yəl	[tʰæyaŋnyəl]
'sun' 'heat'	'solar heat'
tæhak+yaku	[tæhaŋnyaku]
'college' 'baseball'	'college baseball'

    b. Prefixed words

hotʰ-ipul	[honnipul]
'single' 'quilt'	'single-layer quilt'
tət-yaŋmal	[tənnyaŋmal]
'extra' 'socks'	'outer socks'

/n/, which is not present in bare morphemes, appears between two stems of a compound or between a prefix and the following stem when the preceding prefix or stem ends in a consonant and the following stem begins with /i/ or /y/.[2] In accounting for the phenomenon in the framework of Prosodic Phonology, Han (1994) has proposed that /n/-insertion applies at the juncture of two prosodic words. The rule has been formulated as a domain juncture rule as in (2).[3]

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1. Hereafter, I use + to indicate the compounding of two free stems and - to indicate word formation involving bound morphemes. In the transcriptions that follow, allophonic changes such as intersonorant voicing or the l/r alternation will not be specified.

2. The obligatoriness of /n/-insertion is not the same for all cases which satisfy the structural description. /n/-insertion seems to be obligatory for some words but optional for other words. /n/ tends to be inserted more readily when the final consonant of the first constituent is a sonorant, especially /l/, than when it is an obstruent.

3. There is a difference between native Korean words and Sino-Korean words with regard to /n/-insertion; the segmental condition for the second prosodic word is /i/ or /y/ for native Korean words but only /y/ for Sino-Korean words. For instance, while a native compound /patʰ+il/ 'farm work' is realized as [pannil], a Sino-Korean compound /tiŋcaŋ+inmul/ 'characters' is pronounced as [tiŋcaŋinmul], not [tiŋjaŋninmul].

(2) /n/-insertion (Han 1994: 63)
    $\varnothing \rightarrow n$ /[...C]$_{pw}$ _____ [i/y...]$_{pw}$

The Sino-Korean compounds in (3) have a morphological structure different from that of the compounds in (1a). While the compounds in (1a) are made up of two free stems, the compounds in (3a) consist of a free stem plus a bound root and those in (3b) consist of a bound root plus a free stem.

(3) /n/-insertion in asymmetric Sino-Korean compounds
    a. /n/-insertion in the compounds of a free stem and a bound root
       hwipal-yu   [hwipallyu] (<[hwipalnyu])
       'volatile' 'oil'   'gasoline'
       kwancəl-yəm   [kwancəllyəm] (<[kwancəlnyəm])
       'joint' '-itis'   'arthritis'

    b. no /n/-insertion in the compounds of a bound root and a free
       stem⁴
       il-yoil   [ilyoil] (*[illyoil]<*[ilnyoil])
       'sun' 'day of the week'   'Sunday'
       kyəŋ-yaŋsik   [kyəŋyaŋsik] (*[kyəŋnyaŋsik])
       'light' 'Western-style food' 'light Western-style food'

The compounds in (3a) and those in (3b) show different behaviors with regard to /n/-insertion; /n/ appears between two constituents in (3a) but no /n/ is inserted between two constituents in (3b).⁵
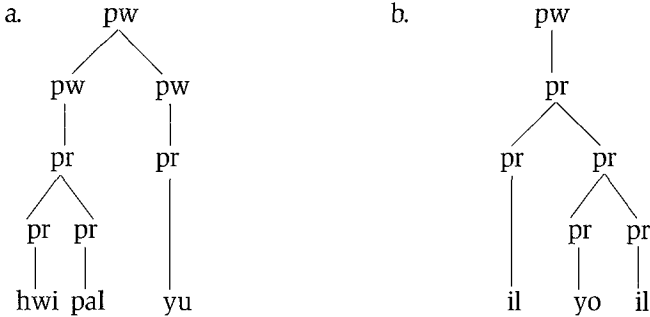
On the assumption that the constituents of a compound must be of

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4. In Kyungsang dialect, /n/-insertion applies in the words in (3b) (e.g. /il-yoil/ → [illyoil]) and even between two bound roots (e.g. /wən-yu/ → [wənnyu] 'crude oil'). This can be treated by changing the prosodic environment of the rule in (2) into the prosodic root. Thus, /n/-insertion applies between two prosodic roots in Kyungsang dialect.

5. Some Sino-Korean words which appear to have morphological structure similar to those in (3b) are subject to /n/-insertion, e.g. /sin-yesan/ → [sinnyesan] 'new budget'. I assume that Sino-Korean morphemes like /sin/ 'new' are assigned the status of a prefix when they are placed before a free stem. As shown in (1b), /n/ is inserted between a prefix and a following stem. In fact, Sino-Korean morphemes like /sin/ can be combined with a free stem much more productively than those in (3b).

the same prosodic type, Han (1994) has proposed that the two types of compounds in (3) have the prosodic structures in (4), respectively.[6]

(4) Prosodic structure (Han 1994 : 67)[7]

a.
```
            pw
          /    \
        pw      pw
         |       |
        pr      pr
       /  \      |
     pr    pr    |
      |     |    |
     hwi   pal   yu
```

b.
```
            pw
             |
            pr
          /    \
        pr      pr
         |     /  \
         |   pr    pr
         |    |     |
         il   yo    il
```

In the compounds of a free stem and a bound root, compounding seems to occur at the level of the prosodic word. In other words, a bound root is assigned the status of the prosodic word as well. On the other hand, compounding appears to take place at the level of the prosodic root in the compounds of a bound root and a free stem. In what follows, I will be particularly concerned with the class of compounds such as in (3a).

3. /l/-/n/ Alternation in Sino-Korean Words

3.1. Syllable Contact Law and the /l/-/n/ Alternation

As illustrated in (5), /l/ in the initial position of a Sino-Korean morpheme is changed to /n/ when it is preceded by a consonant other than /n/ and /l/.

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6. Similarly, Kang (1994) suggests that /hweŋtan-lo/ 'crossroad' and /sinmun-lo/ 'Sinmun Street' are prosodically ω(hweŋtan) ω(lo) and ω(sinmun) ω(lo).

7. The fact that yoil is dominated by a prosodic root in (4b) does not mean that it is a bound root. Han (1994) assumes that a morphological constituent is parsed by every prosodic category. Hence, a free stem is dominated by both a prosodic root and a prosodic word whether it is monomorphemic (e.g. /maim/ 'mind') or derived (e.g. /ki-sul/ 'skill'). (4b) simply suggests that the compounding of /il/ and /yoil/ occurs at the level of the prosodic root.

(5) /l/ is nasalized after a consonant except /n/ and /l/

/kak-lyo/	[kaŋnyo]	'Cabinet member'
/kɨp-lyu/	[kɨmnyu]	'torrent'
/myəŋ-lyəŋ/	[myəŋnyəŋ]	'command'
/kɨm-li/	[kɨmni]	'interest rate'

When the preceding consonant is /n/ as in (6), /l/ is not nasalized but rather it lateralizes the preceding /n/. In addition, as shown in (7), /l/ remains intact when the preceding morpheme ends in /l/.

(6) /l/ lateralizes preceding /n/

/pan-lan/	[pallan]	'rebellion'
/san-lim/	[sallim]	'forest'

(7) /l/ remains intact after /l/

/kyəl-lon/	[kyəllon]	'conclusion'
/mul-li/	[mulli]	'physics'

Davis and Shin (1999) and Kim (2001) have recently proposed that these /l/-nasalization and /n/-lateralization be analyzed through the interaction of a constraint on syllable contact with related correspondence constraints. (8) is a syllable contact constraint phrased in terms of sonority by Bat-El (1996).

(8) Syllable Contact (SyllCon) (Bat-El 1996 : 304)
    The onset of a syllable must not be of greater sonority than
    the last segment in the immediately preceding syllable.
    (That is, avoid rising sonority over a syllable boundary.)

The constraints employed by Davis and Shin (1999) to account for the /l/-/n/ alternation in Korean are listed in (9).

(9) Constraints (Davis and Shin 1999)[8]
   a. SyllCon - Avoid rising sonority over a syllable boundary.
   b. Max[lateral] - The feature [lateral] from an input segment is realized in the output.
   c. Max[nasal] - The feature [nasal] from an input segment is realized in the output.
   d. Ident[sonorant] - Corresponding segments are identical with respect to the feature [±sonorant].
   e. Ident-Onset[sonorant] - The [±sonorant] feature of an output onset is identical to the [±sonorant] feature of the corresponding input segment.
   f. Ident[place] - Corresponding segments are identical with respect to their place features.
   g. *Complex - Avoid complex onsets and complex codas. (undominated)
   h. Similarity - A sequence of coronal sonorant consonants is disallowed.

The tableau in (10) by Davis and Shin (1999) illustrates how /k-l/ sequence in the input is realized as /ŋ-n/. As Davis and Shin state, this and the examples in (5) are of great interest because nasalization occurs even though there is no nasal in the input.

(10) /kyək-li/ - [kyəŋni] 'separation' (Davis and Shin 1999 : 295)

/kyək-li/	SyllCon	Ident-Onset [sonorant]	Ident- [place]	Max- [lateral]	Max- [nasal]	Ident- [sonorant]
a. kyək.li	*!					
b. kyək.ni	*!			*		
c. kyəl.li			*!			*
d. kyəŋ-li	*!					*
☞ e. kyəŋ-ni				*		*
f. kyək-ti		*!		*		*

Since the SyllCon constraint is undominated, (10a), (10b) and (10d) are eliminated. (10e) [kyəŋ-ni], in which both /k/ and /l/ are nasalized, turns

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8. Davis and Shin (1999) view the features [lateral] and [nasal] as being privative.

out to be the most harmonic among the rest of the candidates since Max[lateral] is ranked lower than Ident[place] and Ident-Onset[sonorant].

(11) shows how the constraints in (9) interact to deal with the lateralization of /n/ in the data in (6). The constraint in (9h), Similarity, is motivated to handle /n/-lateralization in the /l-n/ sequence in the words like /cʰul-nap/ ([cʰullap]) 'revenue and expenditure,' in which the initial /n/ of the second root is lateralized although the sonority contour over the syllable boundary is not rising.

(11) /non-li/ - [nol.li] 'logic' (Davis and Shin 1999 : 301)

/non-li/	SyllCon	Ident-Onset [sonorant]	Sim-ilarity	Ident-[place]	Max-[lateral]	Max-[nasal]	Ident-[sonorant]
a. non.li	*!		*!				
b. non.ni					*!		
☞ c. nol.li						*	

There is another environment in which /l/ is realized as /n/. As shown in (12), /l/ is changed to /n/ in the word-initial position.

(12) word-initial /l/-nasalization
      /lon-mun/   [nonmun]   'research paper'
      /lu-su/   [nusu]   'water leakage'
      /lak-wən/   [nakwən]   'paradise'
      /lyək-hak/   [nyəkʰak]>[yəkʰak][9]   'dynamics'

Though some researchers unify word-initial /l/-nasalization in (12) with post-consonantal /l/-nasalization in (5) into one and the same phenomenon, I follow Kang and Lee (1997) and Davis and Shin (1999) in assuming that those two kinds of nasalization must be treated separately. A constraint against word-initial /l/ can be stated as in (13).

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9. Independent of word-initial /l/-nasalization, /n/ is deleted in the word-initial position when it is followed by /i/ or /y/.

(13) Word-initial Avoidance
    *$_{pw}$[l
    "/l/ is prohibited in the initial position of a prosodic word."

3.2. /l/-/n/ Alternation in Asymmetric Sino-Korean Compounds

Now let us consider the examples in (14). Unlike those in (6) and (11), /n/ followed by an /l/ is not lateralized but instead the morpheme-initial /l/ is nasalized (Lee 1996, Kang and Lee 1997, Kim 2000).[10]

(14) /n-l/ sequence in asymmetric Sino-Korean compounds
    /tɨŋsan-lo/   [tɨŋsannno] (*[tɨŋsallo])   'mountain trail'
    /unpan-lyo/   [unpannyo] (*[unpallyo])   'shipping charge'
    /ɨmun-lon/   [ɨmunnon] (*[ɨmullon])   'phonology'
    /ɨykyən-lan/   [ɨykyənnan] (*[ɨykyəllan])   'opinion section'
    /cəŋsin-lyək/   [cəŋsinnyək] (*[cəŋsillyək])   'mental power'
    /toŋwən-lyəŋ/   [toŋwənnyəŋ] (*[toŋwəllyəŋ)   'mobilization order'
    /sæŋsan-lyaŋ/   [sæŋsannyaŋ] (*[sæŋsallyaŋ]   'quantity of production'

What brings about such a distinct result? The words in (14) differ from those in (6) in that the words in (14) are compounds of a free stem and a bound root just like those in (3a) whereas those in (6) are compounds of two bound roots. With respect to /l/-nasalization, the compounds in (14) pattern with those which are composed of two free stems, as exemplified in (15).

(15) /n-l/ sequence in word compounds
    /cəŋsin+lotoŋ/   [cəŋsinnotoŋ] (*[cəŋsillotoŋ])   'mental labor'
    /onkən+losən/   [onkənnosən] (*[onkəllosən])   'moderate approach'
    /cikkwən+lamyoŋ/   [cikk'wənnamyoŋ]
                       (*[cikk'wəllamyoŋ]) 'abuse of one's official power'

The constraints in (9), however, cannot account for the data in (14) and (15). Those constraints predict that (16b), [tɨŋsallo], should be the

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10. According to Lee (1998), the forms with /l/ are sometimes found for some words in (14) (e.g. [ɨmunnon]/[ɨmmullon]) mainly among the aged and in Southern dialects.

winning candidate, but the actual winner for the input /tiŋsan-lo/ is (16c), [tiŋsanno].

(16)

/tiŋsan-lo/	SyllCon	Max[lateral]	Max[nasal]
a. tiŋsanlo	*!		
☞ b. tiŋsallo			*
c. tiŋsanno		*!	

It seems that this unexpected /l/-nasalization can be dealt with using a constraint already introduced before. As it has been proposed in Section 2 that compounds of a free stem and a bound root like /tiŋsan-lo/ have the prosodic structure such as (4a), the constraint on word-initial avoidance of /l/ in (13) will be able to play a role in selecting the intended winner. As shown in (17), Word-initial Avoidance (WIA), ranked higher than Max[lateral], prohibits [tiŋsallo] from being the optimal candidate. Thus, Word-initial Avoidance appears to handle the /l/-nasalization in the /n-l/ sequences in (14).

(17) SyllCon, WIA ≫ Max[lateral] ≫ Max[nasal]

/tiŋsan-lo/	SyllCon	WIA	Max[lateral]	Max[nasal]
a. [tiŋsan]$_{pw}$[lo]$_{pw}$	*!	*!		
b. [tiŋsal][lo]		*!		*
☞ c. [tiŋsan][no]			*	

The compounds in (18) run counter to the analysis of the /l/-nasalization in (17), which crucially employs the constraint on word-initial avoidance.

(18) /l/ is not nasalized after a vowel-final stem in asymmetric compounds
    /uhwe-lo/   [uhwelo] (*[uhweno])   'bypass'
    /hyəŋtʰæ-lon/ [hyəŋtʰælon] (*[hyəŋtʰænon])   'morphology'
    /sopi-lyaŋ/   [sopilyaŋ] (*[sopinyaŋ]>*[sopiyaŋ]) 'quantity of consumption'
    /kwaŋko-lyo/ [kwaŋkolyo] (*[kwaŋkonyo]>*[kwaŋkoyo]) 'advertising rates'
    /ɨyci-lyək/   [ɨycilyək] (*[ɨycinyək]>*[ɨyciyək]) 'will power'

Though the morphological structure of the words in (18) is identical to that of the words in (14), /l/ in the initial position of the righthand constituent is not realized as /n/ but remains unchanged. In this respect, the compounds in (18) differ from the compounds of free stems in (19) as well because /l/ in the initial position of the righthand constituent is nasalized in the compounds in (19).

(19) /l/ is nasalized in word compounds
 /yukcʰe+lotoŋ/ [yukcʰenotoŋ] (*[yukcʰelotoŋ]) 'physical labor'
 /cəŋki+losən/   [cəŋkinosən] (*[cəŋkilosən]) 'regular line'
 /cʰəlto+lyokɨm/ [cʰəlt'oyokɨm]≮[cʰəlt'onyokɨm] 'railroad fare'
         (*[cʰəlt'olyokɨm])
 /yaŋca+lyəkhak/ [yaŋcayəkʰak]≮[yaŋcanyəkʰak] 'quantum dynamics'
         (*[yaŋcalyəkʰak])

One of the characteristics that differentiate the words in (18) from those in (14) is that the free stem of the left side ends in a vowel in the examples in (18) whereas the lefthand constituent ends in a consonant in the examples in (14). (20) shows that the constraints used to deal with the data in (14) wrongly select [uhwe][no] as the optimal candidate.

(20)

/uhwe-lo/	SyllCon	WIA	Max[lateral]	Max[nasal]
a.[uhwe]_pw[lo]_pw		*!		
☞ b. [uhwe][no]			*	

The actual winner must be the faithful one in (20a). This leads us to conclude that we cannot rely on word-initial avoidance to account for the nasalization of the root-initial /l/ in the compounds of a free stem and a bound root.

3.3. Base-identity and the /l/-/n/ Alternation

Similarities in the shapes of morphologically related words have been explored by various researchers such as Kenstowicz (1996), Benua (1997)

and Borowsky (2000), referred to as different terms like uniform exponence, base-identity or output-to-output correspondence. In this section, let us see if the phonological identity between morphologically related output forms will contribute to resolving the /l/-nasalization in the compounds in (14). Consider the tableau in (21) for the input /tiŋsan-lo/.[11]

(21) SyllCon ≫ BI, Max[lateral] ≫ Max[nasal]

/tiŋsan-lo/ base: tiŋsan	SyllCon	BI	Max[lateral]	Max[nasal]
a. tiŋsanlo	*!			
b. tiŋsallo		*		*!
☞ c. tiŋsanno			*	

In this tableau, the candidates are compared with the independently occurring base [tiŋsan] as to whether each of them resembles the base. The most faithful candidate (21a) cannot be the winner since it violates the high-ranking constraint Syllable Contact. (21b), unlike (21a) and (21c), violates Base-identity by lateralizing the stem-final /n/. (21b) and (21c) tie on Base-identity and Max[lateral] but (21b) incurs a violation of Max[nasal] and hence (21c) is the most harmonic candidate.

The ranking established in the tableau (21) correctly predicts that there will be no /l/-nasalization when /lo/ is preceded by a stem that ends in a vowel. This is illustrated in (22).

(22)

| /uhwe-lo/ base: uhwe	SyllCon	BI	Max[lateral]	Max[nasal]
☞ a. uhwelo				
b. uhweno			*!	

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11. At this point, it is in order to consider the words such as /tækwan-lyəŋ/ 'Taekwan Mountain Pass' and /kwaŋhan-lu/ 'Kwanghan Summerhouse.' The morphological structures of the two words look like the words in (14) but instead of /l/-nasalization, /n/-lateralization takes place in these two words. That is, they are pronounced as [tækwallyəŋ] and [kwaŋhallu], respectively. Following Kim (2000), I will attribute this unexpected lateralization to the fact that /tækwan/ and /kwaŋhan/ are proper names and hence are not independently used.

When the lefthand stem ends in a vowel, neither candidate violates SyllCon. (22b) is eliminated because it fatally violates Max[lateral]. Therefore, the faithful candidate (22a) becomes the winner.
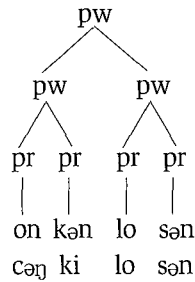
To sum up the discussion so far, in compounds such as /tiŋsan-lo/ the bound morpheme /lo/ does not form a prosodic word by itself. This means that, as illustrated in (23), the prosodic structure of /tiŋsan-lo/ or /uhwe-lo/ is distinct from that of the compounds of two free stems such as /onkən+losən/.
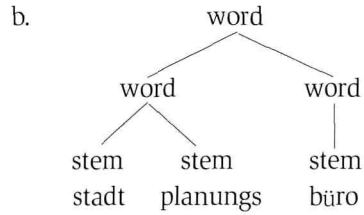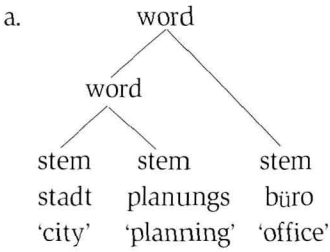
(23)

a. *
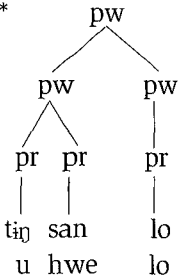
b.

Given the analysis in Section 2 that /n/-insertion takes place between two prosodic words, we are now faced with a serious problem. The prosodic structure required by the analysis proposed to account for /l/-/n/ alternation in Sino-Korean words conflicts with the prosodic structure postulated for /n/-insertion. How can we resolve this conflict and account for /n/-insertion and /l/-/n/ alternation in a compatible fashion? In the following sections, I propose that this conflict can be handled by allowing asymmetric compounds to have non-uniform prosodic structures and modifying the kind of prosodic category referred to in the analysis of /n/-∅ alternation.

4. Minimal Word Structure

Postulating two elementary lexical objects, stems (terminal elements) and words (nonterminal elements), Ito and Mester (1998) show that the three member German compound *Stadt-planungs-büro* 'office for city planning' can be represented by the two structures in (24).

(24)

a.   word   b.   word
          ╱╲   ╱   ╲
       word   ╲   word   word
      ╱╲   ╲   ╱╲   │
  stem   stem   stem   stem   stem   stem
  stadt planungs büro   stadt planungs büro
  'city' 'planning' 'office'

The word structure (24a) violates a widely-held assumption that sister constituents involved in compounds are of the same level. Termed as Uniformity, that assumption is stated as a principle by Ito and Mester (1998) as in (25).

(25) Uniformity (Ito and Mester 1998 : 37)
     Sister constituents in compounds are of the same structural level.

In contrast, the structure (24b) conforms to Uniformity. However, it has an extra intermediate non-branching word node which is not motivated by its semantic relation. Thus, (24b) incurs one more violation of *Struc, a structural economy principle which has the effect of minimizing structure.

As illustrated in (26), if *Struc dominates Uniformity, the non-uniform structure in (26a) would arise. The uniform structure (26b) would result from the opposite ranking Uniformity ≫ *Struc.

(26)

[[stadt-planungs]-büro]	*Struc	Uniformity

a.   word
  ☞ word
   ╱╲   ╲
  stem stem stem
		*

b.   word
   word   word
  ╱╲   │
  stem stem stem
	*!	

Ito and Mester argue that *Struc ≫ Uniformity must be the correct ranking for regular compounding in German since a simple and explanatory account of compound stress is made possible through economy-based compound structures. They maintain that the minimal structure eliminates the need to make direct reference to branchingness in morphological structure to account for compound stress in German. It will be shown in Section 5 that this sort of minimal word structure plays a significant role in analyzing the /l/-/n/ alternation and the /n/-∅ alternation in Korean.
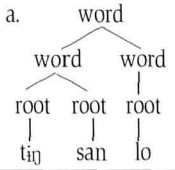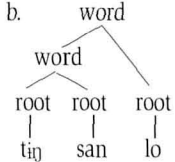
5. Prosodic Structure of Sino-Korean Words

The discussion in what follows is based on the assumption that constraints on morphological structure are ranked independently from constraints on prosodification (Han 1999). First, in Section 5.1, the morphological structure assignment for Sino-Korean compounds will be concerned with and then, the morphology-phonology mapping will be discussed.

5.1. Word Structure

In this section, I propose that *Struc is ranked over Uniformity for Korean compounding as well. The effect of this ranking is demonstrated clearly in the tableau for asymmetric compounds such as the compounds of a free stem and a bound root. (27) is the tableau for /tiŋsan-lo/.

(27)

[[tiŋ-san]-lo]	*Struc	Uniformity

a.   word
     word word
  root root root
  tiŋ san lo
	*!	

☞ b.   word
     word
  root root root
  tiŋ san lo
		*

(27a) has a nonbranching word node over the root /lo/ and this makes it incur one more violation of *Struc. On the other hand, (27b) has simpler structure than (27a) at the expense of violating Uniformity. (27b) wins since *Struc is ranked higher than Uniformity.

By contrast, it is shown in the tableau (28), which is for a compound of two free stems, that the candidate which observes Uniformity is more harmonic because the degree of the structural complexity is identical in the two candidates.

(28)

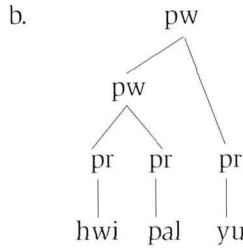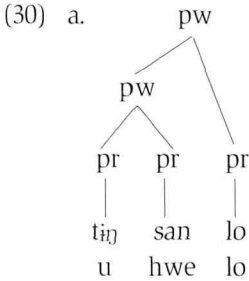| [[on-kən] [lo-sən]]	*Struc	Uniformity
☞ a. word word word root root root root | | | | on kən lo sən		
b. word word root root root root root | | | | on kən lo sən		*!

5.2. Prosodic Structure

Next, let us consider how to map the morphological structure from the tableaux in the preceding subsection to a prosodic structure. The analysis of the morphology-phonology mapping suggested in this section is couched within the Alignment Theory by McCarthy and Prince (1993). Specifically, the alignment constraints between the edges of the morphological word and those of the prosodic word are crucially employed. In addition, Nonrecursivity (NonRec) significantly interacts with the alignment constraints (Selkirk 1995, Truckenbrodt 1999). I propose that the constraints used to account for the prosodification of Sino-Korean compounds are Align-R (Wd, PWd), Align-L (PWd, Wd) and NonRec and that the two alignment constraints outrank NonRec.

The tableau in (29) shows that the constraints and the proposed ranking map the morphological structure in (27b) to the prosodic structure (29a).

(29)

M: word
 	
      word
   root root root
    | | |
    tiŋ san   lo
	Align-R
	(Wd, PWd)
		Align-L
		(PWd, Wd)
			NonRec

P: ☞ a. [[ ]pw]pw			*
b. [ ]pw	*!		
c. [[ ]pw[ ]pw]pw		*!	*
d. [ ]pw[ ]pw		*!	

Thus, as illustrated in (30), a non-uniform morphological structure results in a non-uniform prosodic structure in which a prosodic word and a prosodic root are in sisterhood relationship.

(30) a.   pw   b.   pw

            pw   pw

        pr   pr   pr   pr   pr   pr
        \| \| \| \| \| \|
        tiŋ san   lo   hwi pal   yu
        u   hwe   lo

Since /lo/ does not form a prosodic word by itself, it is obvious that nasalization of the morpheme-initial /l/ cannot be attributed to word-initial avoidance but to some other constraint, that is, Base-identity, as shown in the tableau in (21).

5.3. /n/-∅ Alternation and the Non-uniform Prosodic Structure

Let us now return to the issue of the /n/-∅ alternation. The prosodic

structure of the compound /hwipal-yu/ is identical to that of /tiŋsan-lo/, represented in (30). Taking this prosodic structure into consideration, I propose that the phenomenon of /n/-insertion take place at the juncture of a prosodic word and a prosodic root, not at the juncture of two prosodic words, as formulated in (31).[12]

(31) /n/-insertion (revised)
    $\emptyset \rightarrow$ n /[...C]$_{pw}$ ____ [i/y...]$_{pr}$

In Optimality-theoretic terms (Prince and Smolensky 1993), this can be expressed by a constraint which bans a prosodic word with a final consonant from being adjacent with a prosodic root whose initial segment is a high front vocoid. Thus, a juncture constraint as in (32) will serve the purpose.[13]

(32) Juncture Constraint[14]
    *C]$_{pw}$ $_{pr}$[i/y
    "A prosodic word with a final consonant is prohibited from being followed by a prosodic root which begins with a high front vocoid."

The newly proposed analysis with the modification that the second prosodic constituent is a prosodic root covers the regular word compounds
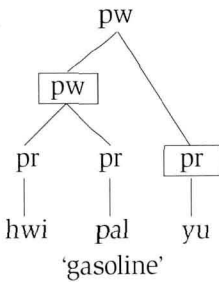
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12. /n/-insertion in (2) and (31) and Juncture Constraint in (32) do not specify the bounding domain within which the juncture must occur. This does not mean that the rule or constraint can apply between any juncture of a prosodic word and a prosodic root. I suppose that there must be a bounding domain for the /n/-$\emptyset$ alternation, probably the phonological phrase, but I leave this issue to future research since identifying the domain is not one of main concerns of this paper.

13. Assuming that the /n/-$\emptyset$ alternation is obligatory when the first prosodic word ends in a sonorant, Cho (1995) formulates Juncture Constraint as *Son][i. However, /n/-$\emptyset$ alternation is optional even when the consonant is a sonorant, e.g. [pamiṣil]/[pamniṣil] 'night dew,' [kʰoŋyət]/[kʰoŋnyət] 'bean taffy.' Hence, I suppose that the first segment in Juncture Constraint is any consonant, not just a sonorant.

14. The function of Juncture Constraint in (32) is simply to ban a specific phonological representation. The fact that violation of Juncture Constraint is resolved by inserting a segment between the two prosodic constituents indicates that Dep is ranked lower than Max. Otherwise, either the preceding consonant or the high front vocoid would be deleted. It still remains to be explained why the inserted consonant is /n/ among the many segments in Korean. I also leave this issue to future research.

and prefixed words as well as the asymmetric compounds. This is because every prosodic word dominates at least one prosodic root. (33) illustrates some examples of the prosodic representations in which Juncture Constraint is violated.

(33) a. Asymmetric compound   b. Regular compound

```
           pw                                      pw
          /  \                                    /  \
      ┌──────┐                              ┌──────┐
      │  pw  │    \                         │  pw  │      pw
      └──────┘     \                        └──────┘     /  \
       /  \     ┌────┐                       /  \    ┌────┐   \
     pr    pr   │ pr │                     pr    pr  │ pr │    pr
     │     │    └────┘                     │     │   └────┘    │
     hwi   pal    yu                       tæ    hak   ya      ku
          'gasoline'                            'college baseball'
```
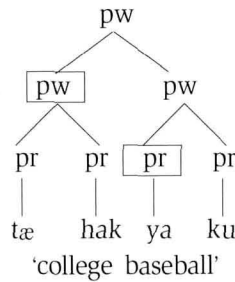
(34) is a tableau for /tæhak+yaku/ 'college baseball,' a compound of two free stems.[15]

(34) SyllCon, Juncture ≫ Base-Identity ≫ Dep

[tæhak]$_{pw}$[yaku]$_{pw}$ base: tæhak, yaku	SyllCon	Juncture	BI	Dep
a. [tæhak][yaku]		*!		
b. [tæhak]n[yaku]	*!			*
☞ c. [tæhaŋ]n[yaku]			*	*

The faithful candidate (34a) fatally violates Juncture since the left prosodic word /tæhak/ ends in a consonant and the following prosodic root /ya/ begins with the high front glide. (34b), having /n/ inserted after the left prosodic word, observes Juncture but it is eliminated because it violates undominated SyllCon. (34c) is the candidate in which the final stop of the first constituent is nasalized. This is the winning candidate, satisfying high-ranking SyllCon and Juncture though it

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15. (34a) does not violate SyllCon since the final consonant of the first prosodic word, k, is syllabified as an onset to the following vowel.

violates low-ranking Base-identity and Dep.

(35) is a tableau for an asymmetric compound /hwipal-yu/ 'gasoline'. None of the candidates in (35) violates SyllCon. In (35a), the stem-final *l* is syllabified as an onset to the following vowel and in (35b) the sonority contour over the syllable boundary is falling.

(35)

[hwipal]$_{pw}$[yu]$_{pr}$ base: hwipal	Similarity	Juncture	BI	Dep
a. [hwipal][yu]		*!		
b. [hwipal]n[yu]	*!			*
☞ c. [hwipal]l[yu]				*

In a parallel fashion to (34a), the fatal violation of Juncture eliminates the faithful candidate, (35a). (35b), with a newly created /l-n/ sequence, fatally violates Similarity though the inserted /n/ rescues it from violating Juncture. Hence, (35c), which has an /l/ instead of an /n/ between the two prosodic constituents, turns out to be the most harmonic.

5.4. Prosodic Categories in Juncture Rules (Constraints)

Selkirk (1980) divides prosodic domain-sensitive rules into three different types: domain span rules, domain juncture rules and domain limit rules. This classification has been followed by many other works on Prosodic Phonology (Vogel 1985 and Nespor and Vogel 1986 and so on).[16] Domain juncture rules, which is the rule type we focus on, can be represented schematically as in (36).

(36) Juncture rules

    i) A → B / [... [... X__Y]$_{Dj}$ [Z ...]$_{Dj}$ ...]$_{Di}$
    ii) A → B / [... [... X]$_{Dj}$ [Y__Z ...]$_{Dj}$ ...]$_{Di}$

---

16. Rice (1990) suggests that domain juncture rules are generally reanalyzable as other types of domain-sensitive rules and hence, domain juncture rules probably do not exist. In opposition to this, Cho (1995) argues that the /n/-∅ alternation in Korean is one of the genuine cases of prosodic juncture rules which cannot be reanalyzed as domain span or domain limit rules.

A juncture rule is applicable when the phonological representation included within the D_i can be factored into smaller prosodic domains in the way specified in the structural description.

In terms of Optimality Theory, domain juncture constraints can be schematized as in (37).

(37) Juncture constraints

$^*[... [... a]_{Dj} [\beta ...]_{Dj} ...]_{Di}$

As demonstrated in (36) and (37), it has been generally assumed that the prosodic domains which form the juncture in juncture rules or constraints are of the same type. The proposal I have made to account for the /n/-$\varnothing$ alternation in this section that a juncture formed by two different types of prosodic categories can be referred to does not conform to this assumption.

Concerning this issue, I maintain that referring to two different types of prosodic categories is not that theoretically problematic although this may look less restricted than the traditional assumption. This is because, as noted by Vogel (1985), all the categories of the prosodic hierarchy are present throughout the phonology. In fact, domain juncture rules or constraints already make use of this aspect of prosodic representation, in that they must simultaneously see both the domain of juncture (D_j) and the domain within which this juncture occurs (D_i). Thus, the question of how many prosodic categories a rule or constraint can make reference to is an empirical one and if it turns out that more categories need to be referred to, the restriction would have to be relaxed.

6. An Alternative Analysis

In this section, I consider another analysis which can also deal with the conflict between the /n/-$\varnothing$ alternation and the /l/-/n/ alternation in asymmetric compounds. The analysis proposed in the preceding section has been able to resolve the conflict by allowing non-uniform prosodic structure for compounds and accordingly making reference to the juncture of two different prosodic categories. The alternative analysis

presented in this section operates by employing uniform prosodic structure for compounds and instead modifying Word-initial Avoidance.

In Section 3.2, the attempt to account for the unexpected /l/-nasalization in asymmetric compounds in (14) by means of Word-initial Avoidance has been given up because Word-initial Avoidance as defined in (13) cannot account for the /l/-nasalization in the compounds in (14) (e.g. /tiɲsan-lo/) without also nasalizing the root-initial /l/ in the compounds in (18) like /uhwe-lo/, in which the stem ends in a vowel. This problem can be solved if we modify the context for Word-initial Avoidance from the prosodic word to the morphological word as in (38).

(38) Word-initial Avoidance (revised)
$*_w[l$
"/l/ is prohibited in the initial position of a morphological word."

Word-initial Avoidance as stated in (38) has no effect on either /tiɲsan-lo/ or /uhwe-lo/, but it only nasalizes /l/ in the initial position of a morphological word as in /lonmun/ 'research paper,' /lakwən/ 'paradise' or /lonmun+cuce/ 'theme of a research.' The nasalization of /l/ in /tiɲsan-lo/ and no nasalization of /l/ in /uhwe-lo/ can be explained by making use of Base-identity and SyllCon as already shown in (21) and (22). Then, how can we account for the nasalization of /l/ in the non-initial member of a compound which consists of free stems? As illustrated in (39) and '(40)', the constraints used in (21) and (22) select the correct outputs for /cəɲsin+lotoɲ/ 'mental labor' and /yukcʰe+lotoɲ/ 'physical labor.'

(39) SyllCon ≫ BI ≫ Max[lat] ≫ Max[nas]

/cəɲsin+lotoɲ/ base: cəɲsin, notoɲ	SyllCon	BI	Max[lat]	Max[nas]
a. cəɲsinlotoɲ	*!	*		
b. cəɲsillotoɲ		*!		*
☞ c. cəɲsinnotoɲ			*	

(40)

/yukcʰe+lotoŋ/ base: yukcʰe, notoŋ	SyllCon	BI	Max[lat]	Max[nas]
a. yukcʰelotoŋ		*!		
☞ b. yukcʰenotoŋ			*	

A change in ranking must be noted here. While the ranking between Base-identity and Max[lat] is undetermined in the cases of asymmetric compounds in (21) and (22), the cases of compounds of free stems, specifically those such as (40), require that Base-identity outrank Max[lat].

The analysis suggested in this section can deal with the data related to the /n/-∅ alternation and the /l/-/n/ alternation without making the juncture constraint specify the juncture between two different prosodic categories. However, it suffers from some weaknesses; it is based on less economic prosodic structure and Word-initial Avoidance must directly refer to an entity in the morphological component.

7. Conclusion

In this paper, I have discussed the /l/-/n/ alternation and the /n/-∅ alternation in Sino-Korean compounds. In particular, I have been concerned with the compounds composed of a free stem and a bound root since they cause a conflict in dealing with those two phonological phenomena. To account for the /n/-∅ alternation in these asymmetric compounds, it was previously proposed that the prosodic structure of these compounds consist of two prosodic words even though the righthand constituent is a bound root. Postulating a non-branching word node over a single bound root, however, results in a wrong output for the /l/-/n/ alternation.

In order to resolve this conflict, I have proposed that the compounds in question are mapped into non-uniform prosodic structure, in which a prosodic word and a prosodic root are in sisterhood relationship. Such non-uniform prosodic structure arises from non-uniform morphological structure. Non-uniform morphological structure itself results from the

ranking by which structural economy takes precedence over uniformity.

With the proposed prosodic structure, the unexpected /l/-nasalization in the /n-l/ sequence in asymmetric compounds can be treated with SyllCon and Base-identiy. According to the newly proposed prosodic structure, it has been needed to redefine the prosodic environment of Juncture Constraint for the /n/-∅ alternation as the juncture of a prosodic word and a prosodic root. Such a modified prosodic context can deal with both regular compounds and asymmetric compounds.

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ABSTRACT

Prosodic Structure of Sino-Korean Words

Eunjoo Han

This paper is concerned with the /n/-∅ alternation and the /l/-/n/ alternation in Sino-Korean compounds. Compounds of a free stem and a bound root center on the discussion of the paper since they show a conflict in dealing with those two phonological phenomena. Specifically, the analysis significantly hinges on the question of what prosodic structure is postulated for that kind of Sino-Korean compounds. This paper proposes to account for the relevant data by characterizing those compounds as having non-uniform prosodic structure and modifying the domain juncture constraint for the /n/-∅ alternation.

Department of English
Seoul Women's University
126 Gongneung 2-dong Nowon-gu
Seoul 139-774, Korea
E-mail : ejhan@swu.ac.kr