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## 1 Introduction

In North Kyungsang Korean (NKK), two-word compounds and phrases always surface with a single high tone, while some larger compounds and phrases have more than one high tone. Importantly, the tonal realization of compounds is entirely parallel to that of phrases, and there is an exact trade-off between compound structure and phrasal structure in tonal realization. The theoretical importance of this trade-off is discussed at the end of section 4. In this paper, we investigate the interaction between phonology and syntax in the realization of high tones in North Kyungsang Korean. In other words, the issue explored in this article is how we can capture the relation between the syntactic structure and the phonological domain within which only one high tone is assigned (sometimes termed the “accentual phrase”).

In this study, we will show that the correct calculation of high tone placement follows directly from the serial application of two phrasing rules and a constraint on phonological phrase (P-phrase) construction. The first rule, Left-boundary insertion (LI), provides the interface with the morpho-syntax. LI inserts a left P-phrase boundary at the beginning of a branching compound or phrase. Within the phonology proper, the second rule, Iterative Constituent Construction (ICC), sub-divides the groupings provided by the interface rule without regard to syntactic constituency, attempting to form binary groups from right to left. However, ICC is subject to a constraint, Avoid (x(, which prevents it from splitting up a ternary group, as this would result in a unary constituent. Therefore, in cases where the LI rule by itself would predict large domains (more than three phonological words) these domains are sub-divided by the ICC to produce smaller binary domains and an initial binary or ternary domain, an effect familiar from footing in word-stress systems such as Garawa.

We will also demonstrate that the P-phrases built by our algorithm, which correctly account for high tone placement, cannot be generated with other theories of the phonology-syntax interface, either end-based (e.g. Selkirk and Shen 1990) or relation-based (e.g. Nespor and Vogel 1986). We will further show that Kenstowicz and Sohn’s (1997, 1999) Optimality Theory (OT) account of NKK P-phrasing cannot capture the relevant aspects of the phonology-syntax mapping. In particular, we argue that it is the pres-

ence of branching structure that conditions P-phrasing rather than head-complement relations or edge alignment to maximal projections in the syntax.

The paper is organized as follows. In section 2, we briefly describe the tonal patterns of simple words, compounds, and phrases in NKK. In section 3 we discuss previous theories of P-phrasing and the problems that ensue for these theories in explaining the NKK P-phrasing. In section 4, we introduce our algorithm for the NKK P-phrasing and show that our proposal gives principled explanations for the parallelism between compound and phrasal tonal patterns, for the contrast between left- and right-branching structures, and for the rhythmic sub-division of left-branching structures. Finally, Section 5 provides a brief summary of the results of our analysis.

## 2 NKK Tonal Patterns

In NKK, simple words exhibit one of four tonal patterns. The four types of tonal patterns are illustrated in trisyllabic words in (1), where acute accents indicate high tone (H).

- (1) a. *múcike* ‘rainbow’ (HHL, H on first two syllables)  
 b. *ácime* ‘aunt’ (HLL, H on first syllable)  
 c. *apúci* ‘father’ (LHL, H on penultimate syllable)  
 d. *satalí* ‘ladder’ (LLH, H on final syllable)

As is the case in various dialects of Japanese (including the standard language), the tonal patterns in (1) are not predictable from the segmental or syllabic composition of the form. As such, the tonal patterns must be memorized for each lexical item. If we analyze (1a) as a doubly-linked H (in accordance with the Obligatory Contour Principle), then we see a broad generalization—each word receives exactly one H. This assignment of a single H is also observed in all two-word compounds and phrases, as illustrated in (2) and (3). (In the following examples, underlining indicates vowels that have H in their isolation forms and we employ the following abbreviations: A = adjective, N = noun, V = verb, S = subject, O = object).

- (2) Two-word compounds
- |                               |                                |                             |                               |
|-------------------------------|--------------------------------|-----------------------------|-------------------------------|
| a. <i>nápi-<u>nekthai</u></i> | b. <i>íyáki-pottá<i>li</i></i> | c. <i>tók<i>u</i>li-pap</i> | d. <i>totúk-koyá<i>Ni</i></i> |
| ‘butterfly’ ‘necktie’         | ‘story’ ‘pack’                 | ‘eagle’ ‘rice’              | ‘burglar’ ‘cat’               |
| ‘bow tie’                     | ‘story teller’                 | ‘victim’                    | ‘stray cat’                   |
- (3) Two-word phrases, including OV and SV
- |  |  |
|--|--|
| a. ( <i>alumtáun<sub>A</sub> muc<i>í</i>ke<sub>N</sub></i> ) | b. ( <i>kímchi<sub>O</sub> mENnU<i>nta</i><sub>V</sub></i> ) |
| ‘beautiful rainbow’  | ‘[e] eats Kimchee’   |

- c. (ácmE<sub>N</sub> kapa<sub>N</sub>)                      d. (akássi-ka<sub>S</sub> canta<sub>V</sub>)  
 'aunt's bag'                                      'lady sleeps'

We will not discuss the intricacies and mechanisms in placing H in compounds and phrases; this is explained in detail in Kim (1999). In the present article we rely only on the fact that there is one prominent tone per P-phrase. It is most important to note the parallelism in the tonal patterns of compounds and phrases, particularly the fact that even the SV combination in (3d) has only a single high tone. The parallelism between compounds and phrases and the limit of one H per P-phrase are the crucial empirical facts which must be covered in any adequate account of NKK P-phrasing, and various theories will be compared on this basis.

In contrast to two-word combinations, compounds and phrases composed of three or more words can exhibit more complex tonal patterns, as shown in (4) and (5).

(4) P-phrasing in 3- and 4-word compounds

- a. (seNsÉ<sub>N</sub>-kake<sub>N</sub>-cúin)                      b. (seNsÉ<sub>N</sub>-kake) (cúin-moim)  
 'fish' 'store' 'owner'                      'fish' 'store' 'owner' 'meeting'  
 'fish store owner'                              'association for fish store owners'

(5) P-phrasing contrasts in 3-word phrases

- a. [[A N]<sub>S</sub> V]                                      b. [S [O V]]  
 (alUmtáun akássi-ka tallinta)              (apúci-ka)(koyáNi-lul manciEssta)  
 'beautiful' 'lady' 'runs'                      'father' 'cat' 'touched'  
 'beautiful lady runs'                              'father touched a cat'

Cases such as (4a) and (5a) have only one H, and therefore one P-phrase, whereas others, such as (4b) and (5b) have more than one H (and P-phrase). These contrasts raise crucial questions as to how word strings are parsed into P-phrases. In the next section, we discuss previous theories of P-phrasing and examine whether they can account for NKK P-phrasing as reflected in the high tone assignment.

### 3 Previous Analyses

#### 3.1 End-based and Relation-based Approaches

There have been three main approaches to the phonology-syntax interface in derivational generative phonology: direct reference to syntax (e.g. Kaisse 1985), end-based construction of P-phrases (e.g. Selkirk and Shen 1990), and relation-based construction of P-phrases (e.g. Nespor and Vogel 1986). We

will not discuss direct-reference theories in this article. Our basic analytic assumption is that one high tone is assigned per P-phrase in NKK. Then, if the formation of P-phrase is defined in relation-based and end-based theories as in (6), some of the NKK P-phrases can be explained, as shown in (7). The examples in (7) are drawn from N-J. Kim 1997 and S-H. Kim 1999.

- (6) a. Relation-based NKK P-phrasing  
A head and its complement (branching or not) form a P-phrase.
- b. End-based NKK P-phrasing  
The left edge of each  $X^{\max}$  coincides with the left edge of a P-phrase.

- (7) a.
- |       |  |                     |
|-------|--|---------------------|
| XP    | (A N)  |                     |
| / \   | (O V)  |                     |
| YP X  | (alUmt <u>á</u> un <sub>A</sub> mucjike <sub>N</sub> ) | ‘beautiful rainbow’ |
| (Y X) | (kímchi <sub>O</sub> mENn <u>U</u> nta <sub>v</sub> )  | ‘[e] eats Kimchee’  |

- b.
- |         |  |                            |
|---------|--|----------------------------|
| XP      | (Adv A N) <sub>φ</sub>   |                            |
| / \     | (A N V) <sub>φ</sub>   |                            |
| YP X    | (méu <sub>Adv</sub> alUmt <u>á</u> un <sub>A</sub> napi <sub>N</sub> ) <sub>φ</sub>              | ‘very beautiful butterfly’ |
| / \     | (hay <u>a</u> n <sub>A</sub> polí-lul <sub>N</sub> mENn <u>U</u> nta <sub>v</sub> ) <sub>φ</sub> |                            |
| ZP Y    | (Z Y X)  | ‘[e] eats white barley’    |
| (Z Y X) |  |                            |

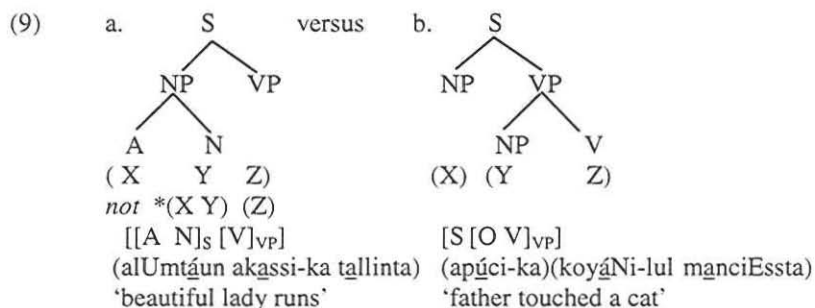
The relation-based approach of (6a) predicts the P-phrasings in (7) because in both cases the final head is grouped with its complement. Likewise, the end-based approach of (6b) predicts the P-phrasings in (7) because in both cases the left edge of every maximal projections is aligned with the left edge of a P-phrase. The fact that a single high tone is assigned to each of the phrases in (7) supports these predictions. However, other cases, to which we now turn, show that the approaches in (6) are empirically inadequate.

### 3.2 An OT Analysis of NKK Phonological Phrasing

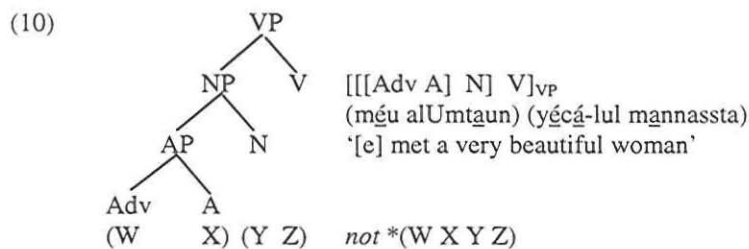
The P-phrasing algorithms of (6) cannot handle the cases in (8)-(10), from N-J. Kim (1997), S-H. Kim (1999), and Kenstowicz and Sohn (1999).

- (8)
- |                    |  |  |                    |
|--------------------|--|--|--------------------|
| S                  | (S V)                                  | (toN <u>s</u> éN <sub>NP</sub> cwúkEssta <sub>VP</sub> )           | ‘brother died’     |
| / \                |  | (aká <u>s</u> si-ka <sub>NP</sub> cantá <sub>VP</sub> )            | ‘lady sleeps’      |
| NP VP              |  | (toN <u>s</u> éN-i <sub>NP</sub> meNn <u>U</u> nta <sub>VP</sub> ) | ‘brother eats [e]’ |
| (X Y) <sub>φ</sub> | not *(X) <sub>φ</sub> (Y) <sub>φ</sub> |  |                    |

As shown in (8), contrary to the prediction made by the end-based and relation-based algorithms in (6), when each of NP and VP consists of a single word, the NP and the VP are not separated but instead are grouped together forming a P-phrase, as shown by the fact that a single high tone is assigned to the string of NP and VP. These algorithms, further, cannot explain why the VP cannot form a separate P-phrase in the left-branching structure of (9a), while the VP separately forms a P-phrase in the right-branching structure of (9b).



Finally, they also incorrectly predict that all the words in (10) should be grouped together in a single P-phrase.



These incorrect predictions are also made by Truckenbrodt's (1995, 1999) OT-based account of P-phrasing, based on the constraints in (11).

- (11) Wrap-XP: Each XP is contained in a P-phrase  
 Align-XP-L: For each XP there is a P-phrase such that the left edge of XP coincides with the left edge of the P-phrase  
 (Truckenbrodt 1999: 223, 228)

Wrap-XP also predicts that (10) should be parsed as a single P-phrase, and Align-XP-L predicts that (8) should be parsed into two P-phrases. Since

Kenstowicz and Sohn (1997, 1999) have already revised Truckenbrodt's theory and have provided an account specifically of NKK P-phrasing, we will concentrate our discussion on their analysis.

Kenstowicz and Sohn propose the constraints and ranking in (12).

- (12) Align-XP<sub>BR</sub>-L: The left edge of each *branching* XP coincides with the left edge of a P-phrase
- » Min-Bin: P-phrases must contain at least two P-words
  - » Max-Bin: P-phrases must contain at most two P-words
  - » Wrap-XP

The more specific constraint, Align-XP<sub>BR</sub>-L, plays a more crucial role in NKK P-phrasing, over-riding the general constraint Align-XP-L. The trend toward binary groups exhibited in (10) is handled by Min-Bin and Max-Bin. They show that the constraint ranking in (12) will correctly analyze the problematic cases of (8–10). The three tableaux in (13) show how the proposed ranking of constraints evaluates output candidates and selects correct P-phrases as the optimal outputs.

(13)

	Align-XP <sub>BR</sub>	Min-Bin	Max-Bin
a. $\mathcal{C}$ (tonse <sub>N<sub>NP</sub></sub> cwúkEssta <sub>VP</sub> )			
(tonsé <sub>N<sub>NP</sub></sub> ) (cwúkEssta <sub>VP</sub> )		*!*	
b. $\mathcal{C}$ (alUmtáun <sub>A</sub> akassi-ka <sub>S</sub> tallinta <sub>V</sub> )			*
(alUmtáun <sub>A</sub> akassi-ka <sub>S</sub> )(tállinta <sub>V</sub> )		*!	
c. $\mathcal{C}$ (méu <sub>Adv</sub> alUmtáun <sub>A</sub> )			
(yéca-lul <sub>N</sub> mannassta <sub>V</sub> )			
(méu <sub>AdvP</sub> alUmtáun <sub>A</sub> yéca-lul <sub>N</sub> mannassta <sub>V</sub> )			*!*

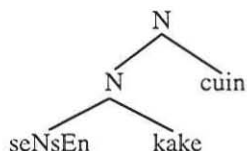
Despite its success with (8)-(10), this analysis has serious problems in explaining the contrast between left- and right-branching structures and the parallelism between tonal patterns in compounds and phrases. In other words, their algorithm, as it stands, cannot explain the P-phrasing of compounds and syntactic phrases that contain compounds, as illustrated in the next section.



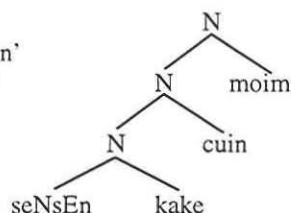
#### 4 Our Proposal: Visibility of Compounds and Rhythmicity

Not all the compounds in NKK have only one high tone. Interestingly, there is an exact parallelism between the tonal patterns in compounds and those in phrases in NKK. Let us consider the examples in (14).

- (14) a. seNsĒn-kake-cuin  
 'fish' 'store' 'owner'  
 'fish store owner'  
 (seNsĒn-kake-cuin)

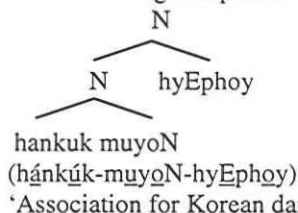


- b. seNsĒn-kake-cuin-moim  
 'fish' 'store' 'owner' 'association'  
 'Association for fish store owners'  
 (seNsĒn-kake)(cuin-moim)  
 not \* (seNsĒn-kake-cuin-moim)

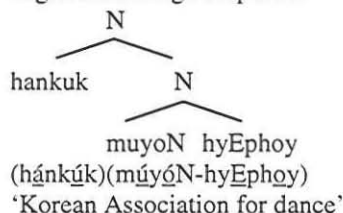


While a single high tone is assigned to the left-branching three-stem compound in (14a), two separate high tones are assigned to the left-branching four-stem compound in (14b), indicating that, like left-branching four-word phrases, this four-stem compound is phonologically divided into two separate groups, (seNsĒn-kake) and (cuin-moim). This similarity in tonal and phrasing patterns between compounds and phrases in NKK is also found in the contrast between left- and right-branching structures in (15).

- (15) a. Left-branching compound



- b. Right-branching compound



While the left-branching compound in (15a) has a single high tone and thus a single P-phrase, the right-branching compound in (15b) has two separate high tones indicating that this compound is divided into two P-phrases. The problem for Kenstowicz and Sohn's analysis is that the proposed ranking among constraints cannot distinguish (15a) from (15b) in phrasing these

compounds phonologically; it incorrectly selects the mono-phrasing compounds as optimal outputs in both cases, as shown in (16).

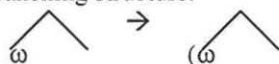
(16)

	Align-XP <sub>BR</sub>	Min-Bin	Max-Bin
☞ (hánkúk-muyóN-hyĒphoy)			
(hánkúk) (múyóN-hyĒphoy)		*!*	

Further problems for their analysis arise in the P-phrasing of syntactic structures containing compounds. We will discuss these cases below, comparing their analysis with our proposal.

The parallel P-phrasing pattern in NKK compounds and phrases leads us to the conclusion that the internal branching of compounds should not be ignored in the NKK P-phrasing; compound structure must be syntactically significant. In other words, the branchingness of compounds is visible in syntax in NKK. It also says that the NKK P-phrasing is related to the internal branching of a syntactic phrase rather than its syntactic constituency in terms of maximal projections. The reliance of P-phrasing on overt branchingness accords with recent findings in Chomsky's (1995) Minimalist Program; we will not pursue this topic in this article, but leave this tantalizing connection for future research. We take this reliance on branchingness to be the sole basis of the syntax-phonology interface in NKK. The interface provides drastically impoverished representations to the phonology. In NKK the property of syntactic branchingness is preserved in the phonology via the insertion of left metrical boundaries, and therefore the interface mapping function is that given in (17).

- (17) NKK Syntax-Phonology Interface: Edge:LLL  
 Insert a *left* parenthesis to the *left* of the *left*-most element for every branching structure.



The interface rule of (17) requires that, if the node wholly containing the elements of a P-word is immediately dominated by the higher node via a left branch, a left boundary of P-phrase is inserted to the left of the P-word. The interface function thus provides a rough-cut P-phrasing from the syntax. In the phonology proper, we observe further sub-division of the crude P-phrases to approximate binary P-phrases, as in (10) and (14b). By locating the sub-division process within the phonology we correctly predict that the sub-dividing will be done without considering any syntactic information. By constructing a modular theory of P-phrasing we correctly predict the limits

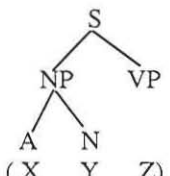
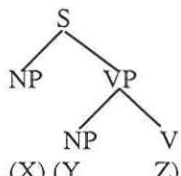
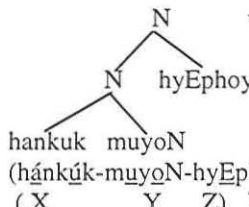
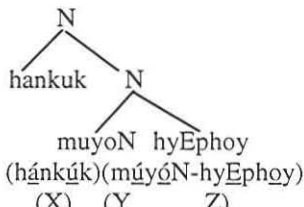
of the syntactic influences on P-phrasing. Binary groups are constructed by the rule (18a) which is subject to the condition (18b).

- (18) a. Iterative Constituent Construction (ICC)  
 Insert a left parenthesis every two P-words from right to left.  
 b. Avoid ( $\omega$ ): Do not create the configuration  $*(\omega$

The net effect of Avoid ( $\omega$ ) is to retain an existing ternary group instead of subdividing it into a unary group and a binary group. Notice that the interface rule (17) is not subject to this condition, so that in right-branching structures unary constituents are allowed. The modular approach predicts such differences in the status of unary constituents.

This algorithm in (17–18) is an extension of Idsardi's (1992) Simplified Bracketed Grids (SBG) model of metrical theory to the phrase-level; while the line 0 boundaries of metrical grid are inserted on the word-level, it is line 1 boundaries that are inserted on the phrase-level in NKK. In other words, the function of our algorithm is to insert left parentheses onto line 1.

This algorithm groups every two-word compound or phrase, including the S V case, as a single P-phrase. It can also differentiate the right-branching structures from the left-branching structures in the P-phrasing of both phrases and compounds. Let us here examine the phrases of (9) and the compounds of (14) again in our analysis.

- (19) a.  versus b.   
 (X Y Z) By (17) (X) (Y Z)
- (20) a.  versus b.   
 (X Y Z) By (17) (X) (Y Z)

As demonstrated in (19) and (20), since the rule (17) inserts a left boundary of P-phrase to the left of every branching structure, regardless of the syntactic constituency of the structure, the right-branching three-word phrase (19b) and compound (20b) have two separate P-phrases, grouping the second and



- (24) [[seNsĒn-kake-cúin]<sub>N</sub>-ul]<sub>NP</sub> pwassta]<sub>VP</sub> '[e] saw a fish store owner'  
 'fish' 'store' 'owner' -obj. 'saw'  
 (seNsĒn-kake- cúin-ul pwassta By (17)  
 (seNsĒn-kake (cúin-ul pwassta By (18)  
 not \*(seNsĒn-kake- cúin-ul pwassta)

Kenstowicz and Sohn's analysis incorrectly predicts that this structure can be parsed in the manner of other VP's consisting of two syntactic words.

Of course there are ways in which Kenstowicz and Sohn's analysis can be modified to handle the data involving compounds. The obvious answer is to add a second battery of constraints referring to compounds instead of XP's. That is, we could add a constraint Align-Compound<sub>BR-L</sub> to deal with data such as (15). But to deal with more complicated cases, we must be able to trade-off violations of Align-Compound<sub>BR-L</sub> for violations of Align-XP<sub>BR-L</sub>. That is, these two constraints must be crucially tied in order to capture the exact parallelism between P-phrasing in compounds and phrases. Alternatively, Kenstowicz and Sohn's analysis could follow the account given here and examine branchingness without reference to syntactic type, replacing Align-XP<sub>BR-L</sub> with Align-BR-L.

Even if these remedies are taken, there remains one major difference between the two approaches. The analysis given in this paper, being highly modular, predicts very limited interactions between syntax and phonology. The modular theory predicts that P-phrase sub-division through (18) should be impervious to syntactic conditioning. This is the correct result for NKK, and it would be of great advantage to NKK language learners if this property followed from principles of Universal Grammar rather than being a contingent property of constraint rankings which the learner would have to acquire. That is, the modular theory allows for a much smaller range of grammars and is thus the preferable theory on the grounds of increased simplicity and learnability.

## 5 Conclusion

In this paper, we have shown that the correct calculation of high tone placement in NKK follows directly from the modular, serial application of two P-phrasing rules: an interface rule (Edge:LLL, (17)) and a rule for sub-dividing the rough-hewn P-phrases created at the interface (ICC, (18)). Our modular approach predicts the insensitivity of the ICC rule to syntactic information. This result must instead be stipulated in OT-based theories. We have also shown that the P-phrases built by the algorithm proposed in this paper, which correctly account for high tone placement, cannot be generated with

other theories of the phonology-syntax interface. In particular, we have argued that it is the presence of branching structure that conditions P-phrasing rather than head-complement relation or edge alignment to syntactic maximal projections.

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