Autosegmental analysis of tone: a case study of Busan Korean.

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Abstract

This paper is aimed at providing an autosegmental analysis of tonal phenomenon of Busan Korean within a framework of lexical phonology. I will present a brief review of important aspect of autosegmantal and lexical theories. I will then offer a detailed portrait of the tonal contrasts found in mono-, di-, and trisyllabic noun (with various affixes) and will propose the 4 classes for representing underlying tones on noun stems: H, LH, HL, and LHL tonal melodies. In addition, I will argue that a different set of tonal rules in each cycle is required to derive tonal patterns in nouns and compounds. My discussion is intended to make two points. First, it is observed that autosegmental phonology can successfully apply to Busan Korean. Second, it is shown that the principles of lexical phonology which was previously established for non-tonal phenomena govern the application of tonal rules at different strata.

Keywords: Busan Korean, Tone, Autosegmental phonology, Lexical phonology

The Busan Korean Tone

In the literature since Huh (1954), Busan Korean (henceforth BK) is considered as a tone language (Chung 1980, Choi 1998; Gim 1998; Lee 1997).[1] [2] Among researchers who uphold the views that BK is a tone language, there is a controversy whether it is a two- or a three-tone system. Based largely on phonetic grounds, Huh (1954), Gim (1998), Lee (1997), an Chang (2007) maintain their view that BK is a tone language with having three distinctive tones which are assigned to each syllable of words: High (H), Mid (M), and Low (L). In Chang (2007), the minimal tonal triplet of monosyllabic words is exemplified to support this view: [mal] H 'horse', [mal] M 'a measuring unit', and [mal] L 'language'. In contrast, Chung (1980) and Choi (1998) argue that BK is not a three-tone language, but is a two-tone system having H and L tones. It is observed that native speakers of BK cannot perceptually distinguish the difference between the H and M tones[3]. It is weak to argue that BK is three-tone system owing to the slight differences between H and M tones are emerged only phonetically. Notwithstanding, it should be taken into consideration that the native speakers cannot percept the differences between two tones distinctively. In this paper, I will maintain that BK is actually a two-tone language with the evidence against a three-tone system found in Chung (1980) and Choi (1998).

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[1] While Jun (2007) and Lee (2009) are against this view and argue that South Kyungsang Korean is a pitch-accent language based on phonetic and phonological criteria. Lee (2009) points out that the tonal pattern is very limited and is not operated in the predicted way. In other words, if it were assumed that South Kyungsang Korean is a two-tone (H-L) system, then the number of output tone pattern on trisyllabic words would be expected to be 8 (2 x 2 x 2), but it does not occur and only four tone patterns on trisyllabic words are observed. In doing so, she argues that this limited number of tonal patterns are indicative of a pitch-accent system. However, I argue that Busan Korean is categorized as a tone language in which underlying lexical entries contains tones as a part with providing an autosegmental analysis. In fact, four tone patterns are observed consistently in mono-, di- and trisyllabic nouns with no increase in proportion to the number of the syllables on words. The consistent number of tone patterns regardless of the number of syllables on words are derived from the finite number of underlying tonal melodies which are assigned to the words in accordance to the Universal Association Conventions and relevant tonal rules.

[2] There is also a hybrid approach proposed by Utsugi (2007) suggesting that some tonal patterns in South Kyungsang Korean are viewed as following pitch accent system while the other ones are as tonal system.

3 Lee (2009) and Kenstowicz (2007) also observe a consistent but very slight difference in pitch accent between these two words (i.e. the H tone in [mal] 'horse' and the M tone in [mal] 'a measuring unit) in their acoustic studies. They also suggest that their test subjects could not perceptually distinguish the two words without any contexts where they can infer the lexical meaning of the words.

The remainder of this paper is organized as follows. In section 2, I provide a brief review on autosegmental phonology and lexical phonology. In section 3, I show the four distinctive tonal patterns found in mono-, di-, and trisyllabic nouns and propose the underlying tones which are supposed to be assigned to noun stems in BK. In doing so, I provide an autosegmental anlaysis to derive tones on compounds in BK with a set of tonal rules at different cycles in the spirit of lexical phonology (Kiparsky 1982). The section 4 concludes the paper and discusses the issues of future research.
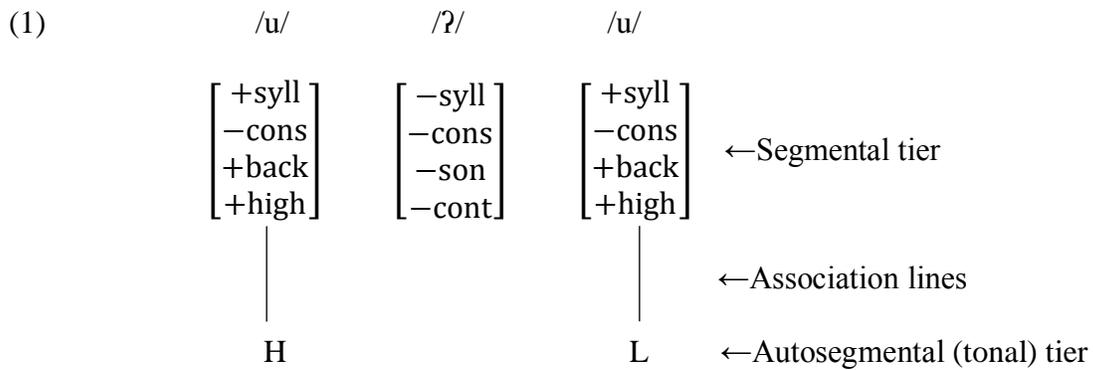
Background

In this section, an overview of important aspects concerning autosegmental and lexical theories as the analysis of tonal patterns of BK primarily based on these two types of theories.

Autosegmental Phonology

Since the phonological theories in the earlier generative grammar (Chomsky and Halle 1968) where phonological representations are linear sequences of feature matrices, there has been a number of studies on suprasegmental issues whose properties are unordered and simultaneous, assuming some form of non-linear representations. Among those various issues, autosegmental phonology was initially emerged to develop theories of tone as its features do not seem to fit in the linear configurations. William (1971) first introduces non-linear approach to treat tone systems in West African languages such as Igbo, Mende and Margi. He assumes that underlying tones are posited on separate tier from the one that represents the matrices of distinctive feature of segments. He forms a tone (left-to-right) mapping principle that applies in the course of derivation to link tones onto tone-bearing units (or syllables) and create a single-tiered representation in surface structure. This idea is innovated in Goldsmith' (1976) dissertation. He

refutes that it is not tone mapping rules that merge tonal and segmental representations, but argues that it is association lines which links two tonal and segmental elements. In other words, phonological representations consist of parallel tiers which are both tonal and segmental tiers. The tonal tiers are also called as autosegmental tiers in that the elements of this tier are sequentially ordered, linked by the association lines, and operated independently throughout derivation. For example, the word [úʔù] 'fire' in Margi is represented in multi-tiered configurations as illustrated in (1).

$$
(1) \qquad /u/ \qquad\qquad /ʔ/ \qquad\qquad /u/
$$

$$
\begin{bmatrix} +\text{syll} \\ -\text{cons} \\ +\text{back} \\ +\text{high} \end{bmatrix} \quad \begin{bmatrix} -\text{syll} \\ -\text{cons} \\ -\text{son} \\ -\text{cont} \end{bmatrix} \quad \begin{bmatrix} +\text{syll} \\ -\text{cons} \\ +\text{back} \\ +\text{high} \end{bmatrix} \quad \leftarrow\text{Segmental tier}
$$

←Association lines

H   L   ←Autosegmental (tonal) tier

In fact, Pulleybank (1986) developed an autosegmental theory with the revision of universal principles termed Association Conventions and Well-formedness Condition as described in (2) and (3).

(2) Association Conventions (Pulleybank 1986):

Map a sequence of tones onto a sequence of tone-bearing units (henceforth TBUs),

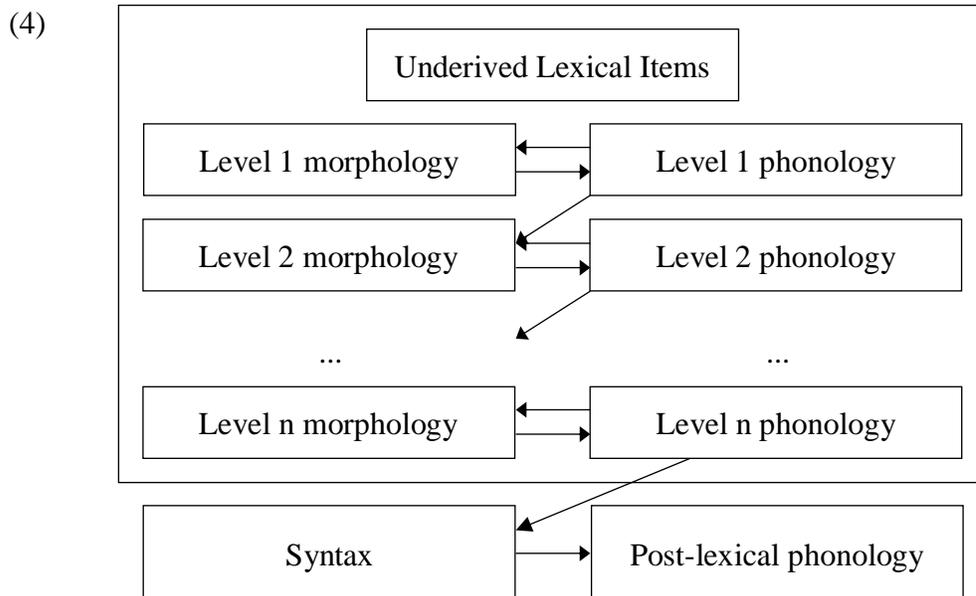(a) from left to right

(b) in a one-to-tone relation.

(3) Well-formedness Condition (Pulleybank 1986):

Associatoin lines do not cross.

These two principles not only define the theoretical way of interacting with tiers, but also confined the violated configurations that the associating operations must avoid in multi-tiered structure.

Lexical Phonology

In early generative grammar the phonological component mapped surface syntactic structures onto a phonetic representation (Chomsky and Halle 1968). In this theory of syntax, word-formation rules were assumed as a subset of syntactic rules and morphological operations are also performed by syntactic transformation. As the phonology has no access to a morphonological string of a word whose representation is determined after the syntactic operations, all phonological rules can apply post-syntactically. However, Kiparsky (1982) and Halle and Mohanan (1985) propose the theory of lexical phonology to challenge the SPE's view on the grammar. In lexical phonology, the phonological rules are divided into two types: the one that applies within the lexicon (i.e. lexical rules), and the other that applies to the output of syntactic operations. The model is represented schematically as follows (Kiparsky 1982):

(4)

Underived Lexical Items

Level 1 morphology	⇄	Level 1 phonology
Level 2 morphology	⇄	Level 2 phonology
...		...
Level n morphology	⇄	Level n phonology

| Syntax | → | Post-lexical phonology |

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In the diagram (4), it is shown that a lexical item undergoes affixation at any of ordered levels. After morphological operation such as affixation or compounding, it is proposed that lexical phonology refers to the morpheme classes as levels or strata and submits the output of word formation at any levels to the phonology to apply relevant phonological rules to derived strings. In this respect that lexical rules can re-apply after each step of word formation at each stratum, the rules of lexical phonology are cyclic. Under the Strict Cycle Condition (Kiparsky 1982), it is allowed for these lexical rules to apply only to environments newly derived. After the syntactic processes, the rules of post-lexical phonology to derived strings, on the other hand, are intrinsically noncyclic.

<div align="center">

The Four Classes of Tone Patterns in BK
</div>

This section investigates the various tone patterns observed in BK words. Regarding the consistent and regular patterns after suffixation, I propose the underlying representation of tone melodies posited in the autosegmentals by categorizing into four groups.

Group 1: High (H) Melody

Consider the data in (5) for the words categorized into Group 1 shown with various suffixes attached:

(5) Group 1 Tone Patterns of BK with Affixation

    a. Monosyllabic Noun

mwúl	H	'water'
mwúl-í	H-H	'water (nom.)'
mwúl-kkáci	H-HL	'up to water'
mwúl-í-myen	H-H-L	'if water'

    b. Disyllabic Noun

kúlúm	HH	'cloud'

kúlúm-i	HH-L	'cloud (nom.)'
kúlúm-kkaci	HH-LL	'up to cloud'
kúlúm-i-myen	HH-L-L	'if cloud'

c. Trisyllabic Noun

mwúcíkay	HHL	'rainbow'
mwúcíkay-ka	HHL-L	'rainbow (nom.)'
mújíge-kkaci	HHL-LL	'up to rainbow'
mwúcíkay-Ø-myen	HHL-L	'if rainbow'

The behavior of monosyllabic noun stems under affixation indicates that there is a in fact consistent tonal patterns. For example, *mwúl* 'water' have an H tone in isolation. When the monosyllabic suffix *-i* (nominative case marker) is suffixed, the tonal pattern for 'water' is *mwúl-í* (H-H). When expanded to the disyllabic suffix *-kkaci* 'up to', the tonal patterns are *múl-kkáci* (H-HL). Finally, when suffixed with *-imyen* 'if', the patterns are *mwúl-í-myen* (H-H-L). Based on data of monosyllabic noun with affixation, it is observed that the first two TBUs are assigned H tones and the rest syllables are linked to L tones. Likewise, the disyllabic noun stem *kúlúm* and the trisyllabic noun stem *mújíge* presents the analogous patterns. Consider the tonal pattern *mújíge*, *-kkaci* (HHL-LL) which can exhibit the maximum length of the tonal pattern along with five TBUs in this paper. I propose that the nouns which belong to the Group 1 have only a single H tone in the underlying structure. Building from Obligatory Contour Principle (henceforth OCP) proposed by Leben (1973), adjacent identical tones are banned from the lexical representation. Although it is observed *the* sequence of two H tones in the surface structure, I assume that an association line, which connects the first TBU to H tones, spreads to the next TBU that is floating without any tones to be associated with, as shown in (6)a. Since OCP enforces the multiple linking in underlying representation, the word *mwúl-í* has only a single H tone, not a two H tones in its lexical entries as described in (6)b.

(6) a. *mwul-i*   →   *mwul-i*   → *mwul-i*

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        H              H              H
*b. mwul-i     →    mwul-i
                       │ │
    H H                H H
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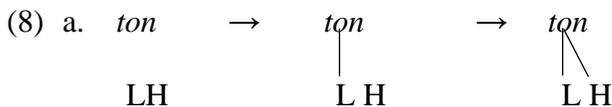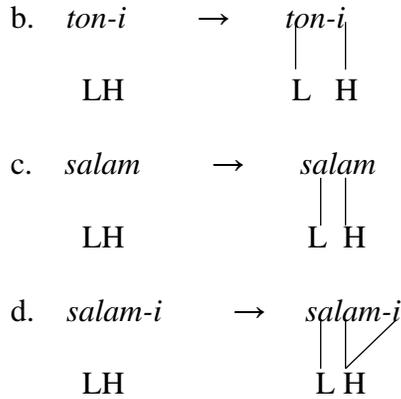
Group 2: Low-High (LH) Melody

In Group 2, another consistent tonal pattern in the words is shown as follows:

(7) Group 2 Tone Patterns of BK with Affixation

a. Monosyllabic Noun

tŏn	R	'money'
ton-í	L-H	'money (nom.)
ton- kkácí	L-HH	'up to money'
ton-í-myén	L-H-H	'if money'

b. Disyllabic Noun

salám	LH	'person'
salám-í	LH-H	'person (nom.)'
salám-kkáci	LH-HL	'up to person'
salám-í-myen	LH-H-L	'if person'

c. Trisyllabic Noun

mintúlléy	LHH	'dandellion'
mintúlléy-ka	LHH-L	'dandellion (nom.)'
mintúlléy-kkaci	LHH-LL	'up to dandellion'
mintúlléy-i-myen	LHH-L-L	'if dandellion'

Note that the monosyllabic noun *ton* is suffixed with *-í* it seemingly has different pattern *ton-í* (L-H) from the monosyllable noun stem *tŏn*, which shows a Rising (R) tone pattern. The di- and trisyllabic nouns behave in parallel in having an LH tone melodies on the first and second syllables and an additional H tone if they are available. I propose that the tonal elements in the autosegmentals of Group 2 are L and H tones, considering that this group has consistent tone patterns regardless of the suffixes.

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(8)  a.   ton       →      ton       →      ton
                            │               │ \
          LH                L H             L H
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b. *ton-i* → *tọn-i*

    LH   L H

c. *salam* → *salam*

    LH   L H

d. *salam-i* → *salạm-j*

    LH   L H

Unlike the examples of (8)b.-c., the number of TBU is less than that of tonal elements to be linked to. After associating L tone with the one and only TBU in the one-to-one fashion, the remaining H tone is docked to the TBU that is previously linked to. Consequently, it results in R tones in monosyllables of Group 2. In the same way, the disyllabic noun *salam-i* is realized as *salám-i* (LH-H) with suffixed by the nominative case marker –*i* as illustrated in (8)d. The first and second TBUs are connected to L and H tones each, and the last association line spreads to the last TBU. The tona pattern of di- and trisyllables have in common in having a L tone on the first syllables and a H tone on the second and third syllables. The paradigm in (7) indicates that the words of Group 2 showing seemingly different tonal patterns have the same underlying representations (i.e. L and H tones) in the autosegmentals and can be derived as the association lines connects segmental and tonal tiers under the association convention and OCP.
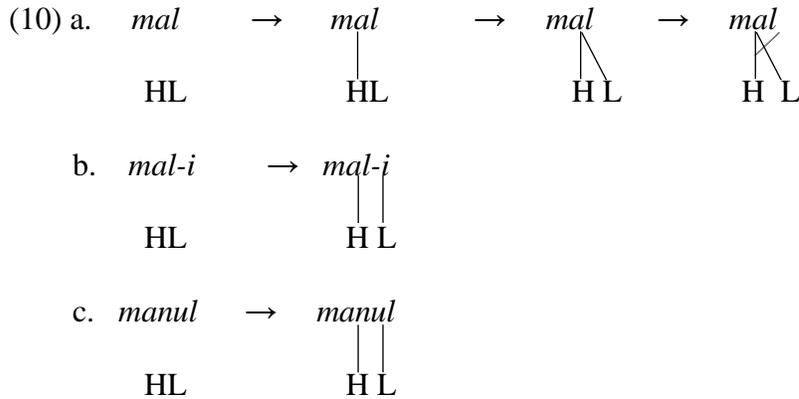
Group 3: High-Low (HL) Melody

       Consider the data in (9) that is assumed to belong to Group 3. W can observe the parallels among the mono- and polysyllabic nouns.

    (9) Group 3 Tone Patterns of BK with Affixation

       a. Monosyllabic Noun

mún	H	'door'
mún-i	HL	'door (nom.)'
mun-kkáci	LHL	'up to door'
mún-i-myen	HLL	'if door'

b. Disyllabic Noun

mánul	HL	'garlic'
mánul-i	HL-L	'garlic (nom.)'
mánul-kkaci	HL-LL	'up to garlic'
mánul-i-myen	HL-LL	'if garlic'

c. Trisyllabic Noun

myénuli	HLL	'daughter-in-law'
myénuli-ka	HLL-L	'daughter-in-law (nom.)'
myénuli-kkaci	HLL-LL	'up to daughter-in-law'
myénuli-i-myen	HLL-L-L	'if daughter-in-law'

Note that disyllables in *mánul* exhibits HL tone patterns, and after the suffixation, *mánul-i,* and

mánul-kkaci behave in parallel in having an H tone on the first TBU and L tones on the rest

syllables if they are available.

(10) a.　*mal*　　→　*mal*　　→　*mal*　　→　*mal*

　　　　HL　　　　HL　　　　H L　　　　H L

b.　*mal-i*　→　*mal-i*

　　　HL　　　　H L

c.　*manul*　→　*manul*

　　　HL　　　　H L

In (10)a., a L and H tones dock to the a single TBU in the monosyllable. However, an interesting

phenomenon is captured as a falling (F) tone is avoided to give rise to in the surface structure,

instead only a H tone is realized with an association line linking L tone is deleted. It could be

taken into consideration as a language specific rule. On the other words, a TBU in BK can be

associated with two lines that connects both a L and H tones together, resulting into a R tone, but

it is not allowed to create a F tone. Except the cases in monosyllables, the polysyllabic nouns

with affixations present a coherent tone melody (HL) regardless of the number of syllables in that the first and second syllables are connected to a H and L tone each, and the rest of them is realized as a sequences of L tones in the surface representation.

Group 4: Low-High-Low (LHL) Melody

Observe that the underlying tone melodies (LHL) found in the mono- and polysyllabic words of Group 4.

(11) Group 4 Tone Patterns of BK with Affixation

    a. Monosyllabic Noun

       Accidental Gap

    b. Disyllabic Noun

palám	LH	'wind'
palám-i	LH-L	'wind (nom.)'
palám-kkaci	LH-LL	'up to wind'
palám-i-myen	LH-L-L	'if wind'

    c. Trisyllabic Noun

kkamákwi	LHH	'crow'
kkamákwi-ka	LHH-L	'crow (nom.)'
kkamákwi-kkaci	LHH-LL	'up to crow'
kkamákwi-i-myen	LHH-L-L	'if crow'

This group exhibits very similar patterns with the Group 2 (LH). However, we can observe the difference when we add various suffixes to the corresponding nouns. The tone pattern of the disyllabic noun stem *palám* suffixed by *–i,* is *palám-i* (LH-L), while that of disyllabic noun stem *salám* of Group 2 suffixed by *–i,* is *salám-í* (LH-H). When the disyllabic suffix *–kkaci* is added to the disyllabic noun stems, that the tonal pattern of Group 4 is *palám-kkaci* (LH-LL), while the one of Group 2 is *salám-kkáci* (LH-HL).

(12) a. *salam*   →   *salam*

         LH   L H

    b. *salam-i*   →   *salam-i*

LH   L H

c. *palam*   →   *palam*   →   *palam*   →   *palam*
                       | | | /\ | /\
LHL   L HL   L HL   L HL

d. *palam-i*   →   *palam-i*
                       | | |
LHL   L H L
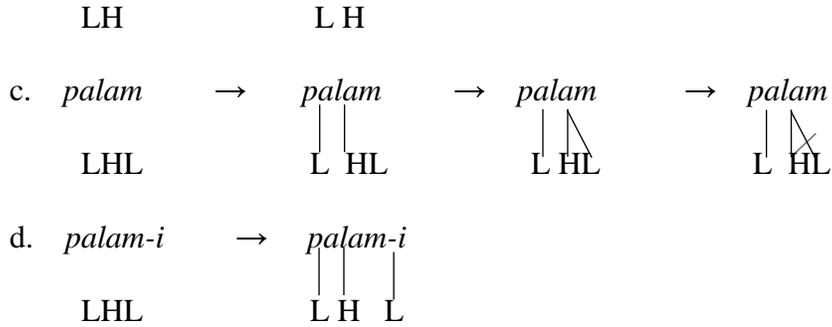
Moreover, the trisyllabic nouns behaves in the parallel ways in that the first three TBUs are associated to a L, H and L tone each, and remaining TBUs are realized as linked to the L tones.

The tonal rules

Observe that the underlying tone melodies are lexically defined within 4 groups. Consider the above data form (5) – (12), a single H tone is adjoined to H tone in the surface representation, whereas there is no limitation on how many L tones can be associated to the TBUs in a row. In this reason, I pose the constraints on H tone spreading: H tone can spread only once. Moreover, compare the cases that the number of underlying tones outnumbers that of TBU units. The monosyllabic noun of Group 2 such as *ton* are realized as a *tǒn* (R) which is the combination of L and H tone. On the contrary, the monosyllabic nouns of Group 3 (HL) such as *mun* are realized as H, and the disyllabic nouns of Group 4 (LHL) such as *palam* are so as L-H melody, not as L-Falling. It tells us that BK disallows the realization of falling tone that is the combination of H and L tone, thereby *Falling Simplification* rule is imposed. Lastly, consider the case where there is still lack of tones to be associated to the TBUs after tone preading. Although the H tone is assumed to spread to another TBU, some syllables need more tones to be linked to. For instance, the TBU *i* in the last syllable *ci* of the monosyllabic noun *mul-kkaci* still and the TBUs in the last two syllables (i.e. *kka* an *ci*) of the disyllabic noun *kulum* require more tones to be linked to. All

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those TBUs are associated with L tones. Taking it into consideration, a L tones is default one that

is supposed to be inserted, as a last resort. The examples of tonal association and derivation is

illustrated in (13):

(13)   salam salam-i salam- kkaci   palam   palam-i   palam- kkaci   *UR*

       L H L H   L H   L H L   L H L   L H L

     salam salam-i salam-kkaci   palam   palam-i palam- kkaci   *Association*

     ⎹ ⎹ ⎹ ⎹   ⎹ ⎹   ⎹ ⎹ℏ   ⎹ ⎹   ⎹ ⎹   ⎹   *Convention*

    L H   L H   L H   L H L L H L   L H   L

    inappl. *inappl.* *inappl.*   palam   *inappl.* *inappl.*   *Falling*

                       ⎹⟋ ⎹ℏ   *Simplification*

                       L H L

    inappl. salam-i salam-kkaci   *inappl.* *inappl.* *inappl.*   *H-spread*

          ⎹ ⎹→ ⎹ ⎹→

        L H   L H

    inappl. inappl. salam- kkaci   *inappl.* *inappl.* palam- kkaci *Default-L*

               ⎹ ⎹→ ⎹   ⎹ ⎹   ⎹   *Insertion*

           L H   L   L H   L L

    salam   salam-i salam- kkaci   palam   palam-i palam- kkaci   *SR*

     ⎹   ⎹ ⎹ ⎹→ ⎹ ⎹→ ⎹   ⎹ ⎹   ⎹ ⎹   ⎹ ⎹   ⎹

     L H L H   L H   L   L H   L H L L H   L L

Those rules successfully derive the tonal melodies of the mono-, di-, and tri-syllabic nouns (with

suffixes) of the 4 groups except for the monosyllabic nouns with a disyllabic suffix such as *mun-*

kkaci (L-LH). In sum, the followings are the sequential order of tone assignment rules of BK that

accounts for the derivation process from the Underlying to Surface level:

(14) The tonal rules in BK

   a. Association Convention

   b. Falling Simplification

   c. H-spread

   d. Default L-insertion

Treatment Tone Interplay Between Autosegmental And Lexical Phonology

In this section, I deal with composite tone[4] in BK noun-noun compounds. Consider when tone patterns of compounds where two nouns of Group 1 are combined.

(15) Root 1 (Group 1:H) + Root 2 (Group1:H)
    a. [nwún] 'eye' + [mwúl] 'water' → [nwúnmwúl] 'tears' (HH)
    b. [pí] 'rain' + [sólí] 'sound' → [písóli] 'the sound of rain' (HHL)
    c. [phárí] 'fly' + [nwún] ' eye' → [phárínwun] 'fly's eye' (HHL)
    d. [kwúlúm] 'cloud' + [kúlím] 'drawing→ [kwúlúmkulim] 'drawing of clouds (HHLL)

From the di- and tri- and tetrasyllabic compounds, the tonal pattern is exactly matched up the tonal melodies in that the first and second syllables have H tones an L tones follows at the end of the syllables. Assume that morphological operation of compounding creates a new strata and submit the strings to the autosegmental phonology. In this level, whatever the tonal melody the second noun stem has in the lexical entries, the autosegments of the second one in the lexical underlying representation are deleted (i.e. Tone Deletion rule) and the set of ordered rules defined in (14) are applied sequentially.

$$(16)\left[\left[\begin{array}{c}\text{pi}\\ \\ \text{H}\end{array}\right]+\left[\begin{array}{c}\text{soli}\\ \\ \text{H}\end{array}\right]\right] \rightarrow \left[\left[\begin{array}{c}\text{pi}\\ \\ \text{H}\end{array}\right]+\left[\begin{array}{c}\text{soli}\\ \\ \ \end{array}\right]\right] \rightarrow \left[\begin{array}{cc}\text{pi}&\text{soli}\\ \\ \text{H}&\end{array}\right] \rightarrow \left[\begin{array}{cc}\text{pi}&\text{soli}\\ \square&\\ \text{H}&\end{array}\right]$$

$$\rightarrow \left[\begin{array}{cc}\text{pi}&\text{soli}\\ \square_\rightarrow&\\ \text{H}&\end{array}\right] \rightarrow \left[\begin{array}{cc}\text{pi}&\text{soli}\\ \square_\rightarrow&\square\\ \text{H}&\text{L}\end{array}\right]$$

As in the diagram in (16), the underlying H tone in the second root *soli* is deleted after compounding. After that tonal rule applies, an association line link a H tones of the first stems to

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[4] In Sebastian (2006), the term "composite tone" is used for a combination of the two tonal melodies for which the respective noun roots are lexically specified.

the first TBU and H-spreading rule docks the second TBU to the previously linked H tones.

When the default L tone is inserted as a resort, the surface tone pattern is derived correctly.

Consider another example of composite tone where the first stem of compounds belongs to

Group 2(LH) and the second one comes from Group 3 (HL), as described in (17).

(17) a. [mǎl] 'speech'+ [mún] 'door'   → [malmún] 'talkbox' (LH)
 b. [tŏl] 'stone'+[sáykkal] 'color'   →[tolsacykkál] 'color of stone'(LHH)
 c. [tampáy] 'cigarette'+[cáy] 'ash'   →[tampáycáy] 'cigarette ashes' (LHH)
 d. [nongkwú] 'basketball' +[kámtok] 'couch'
          → [nongkwúkámtok] 'basketball couch'(LHHL)

As the first stem is specified for a LH tone pattern and the HL melody is assumed to be removed

by the tone deletion rule after compounding, the composite tone of the trisyllaic compound

tolsaykkal 'color of stone' is derived as follows:

(18) a. $\left[\begin{bmatrix} \text{tol} \\ \\ \text{LH} \end{bmatrix} + \begin{bmatrix} \text{sakkal} \\ \\ \text{HL} \end{bmatrix}\right] \rightarrow \left[\begin{bmatrix} \text{tol} \\ \\ \text{LH} \end{bmatrix} + \begin{bmatrix} \text{sakkal} \\ \\ \end{bmatrix}\right] \rightarrow \begin{bmatrix} \text{tolsakkal} \\ \\ \text{LH} \end{bmatrix}$

$\rightarrow \begin{bmatrix} \text{tolsakkal} \\ \square \quad \square \\ \text{L} \quad \text{H} \end{bmatrix} \rightarrow \begin{bmatrix} \text{tolsakkal} \\ \square \quad \square_{..} \\ \text{L} \quad \text{H} \end{bmatrix}$

*b. $\left[\begin{bmatrix} \text{tol} \\ \\ \text{LH} \end{bmatrix} + \begin{bmatrix} \text{sakkal} \\ \\ \text{HL} \end{bmatrix}\right] \rightarrow \begin{bmatrix} \text{tolsakkal} \\ \\ \text{LHHL} \end{bmatrix}$

The tonal melody of the compound in (16) and (18) seems to preserve the tones of each stems,

but the tone deletion rule must apply right after the compounding. In the example of (18)b., if

the tonal melody of the second noun stem were not deleted, it violates the OCP as two H tones

are adjacent in the underlying representation.

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However, there is a puzzling case that tone deletion rule leads to the wrong surface forms, when the both noun stems comes from Group 4 (HL).

(19) a. [swúl] 'alcohol'+ [pyéng] 'bottle' → [swúlpyeng] 'liquor bottle' (HL)
    b. [mál] 'horse'+[méli] 'head'→[tolsáykkál] 'hairlace' (LHH)
    c. [méli] 'head'+[ttí] 'band' → [melíttí] 'hairlace' (LHH)
    d. [twáyci] 'pig' +[wúli] 'cage' → [twaycíwúli] 'pigsty' (LHHL)

As shown in (19) above, only tone pattern of the disyllabic compound is derived in the predicted ways. From tri- and tetrasyllabic compounds, there seems to be another rule that is simultaneously invoked in the application of tone deletion rule on the string at the level of compounding: Tone shift.

(20) a.
$$\left[\begin{bmatrix} \text{twayci} \\ \text{HL} \end{bmatrix} + \begin{bmatrix} \text{wuli} \\ \text{HL} \end{bmatrix}\right] \rightarrow \left[\begin{bmatrix} \text{twayci} \\ \text{LH} \end{bmatrix} + \begin{bmatrix} \text{wuli} \\ \ \end{bmatrix}\right] \rightarrow \begin{bmatrix} \text{twayciwuli} \\ \text{LH} \end{bmatrix}$$

$$\rightarrow \begin{bmatrix} \text{twayciwuli} \\ \square \quad \square \\ \text{L \quad H} \end{bmatrix} \rightarrow \begin{bmatrix} \text{twayciwuli} \\ \square \quad \square_{\leftrightarrow} \\ \text{L \quad H} \end{bmatrix} \rightarrow \begin{bmatrix} \text{twayciwuli} \\ \square \quad \square_{\leftrightarrow} \ \square \\ \text{L \quad H \quad L} \end{bmatrix}$$

As it is odd to posit a specific rule that applies only to certain strings, referring to their tonal segments in the underlying representations, there is need to conduct a future research on this puzzling case.

In the following table (21), the paradigm for the composite tone pattern of noun-noun compounds is summarized. Except for the shaded case, the underlying tone of the second noun stem is deleted in whole. This tone deletion rule is first applied right after morphological operation (i.e. compounding), and after the bracket erases then the set of rules cyclically follows it.

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(21)

Root 1 \ Root2	Group 1 (H)	Group 2 (LH)	Group 4 (LHL)	Group 3 (HL)
Group 1 (H)	H(HLL)	H(HLL)	H(HLL)	H(HLL)
Group 2 (LH)	LH(HL)	LH(HL)	LH(HL)	LH(HL)
Group 4 (LHL)	LHL(L)	LHL(L)	LHL(L)	LHL(L)
Group 3 (HL)	HL(LL)	HL(LL)	HL(LL)	LH(HL)

Concluding Remarks

In this paper, I have investigated various tonal patterns in the mono- and polysyllabic nouns and in the noun-noun compounds. Concerning that the consistent tonal melodies are exhibited after affixations, I have proposed the four underlying tones of BK in the autosegmentals: H, LH, HL, and LHL. It has shown that the tone patterns of words in each four group are successfully derived in accordance with the set of ordered tonal rules: H-spreading, Falling specification, and Default-L insertion. Lastly, when two noun stems are compounded, elements of the second stem are eliminated in the lexical entries and the ones of the second stem are linked in one-to-one fashion. When these autosegmental processes are treated within a lexical framework, it is possible to successfully predict the surface representation of tonal pattern, assuming that the output strings of morphological operation are submitted to the autosegmental phonology and a particular set of tonal rules is applied cyclically at the corresponding levels.

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