# TONE AND METRICAL STRUCTURE IN SEOUL KOREAN

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## 1 Introduction

The present paper seeks to uncover the basic nature of the prosody of Seoul Korean, which still remains controversial. Some studies argue that Seoul Korean has neither lexical stress nor pitch accent (Jun 1993, 1998, 2007; among others). Instead, these studies argue that Low-High-Low-High (LH-LH) is the default phrasal tonal pattern of an Accentual Phrase (AP) unless an AP-initial segment is a tensed or aspirated voiceless stop. (See Silva 2006 and Kang 2014 for a tonogenesis-like sound change in Korean voiceless stops.) On the other hand, other studies claim that Seoul Korean has iambic stress (Lee 1989; Ko 1999, 2010; among others). These studies assume that Korean has lexical stress and that vowel shortening or lengthening is derived from the lexical stress.

Even though both the tonal approach and the stress approach provide evidence to support their ideas, neither of them is satisfactory. The tonal approach only describes the surface realization of tonal patterns and fails to give a theoretical explanation of why LH-LH is preferred over other possible tonal patterns. For example, given that a H tone is universally marked (de Lacy 2002), it is questionable why LH-LL or LL-LH is not preferred over LH-LH. Likewise, why HL-HL is never observed in Seoul Korean remains unanswered within their framework. In contrast, the stress approach provides a theoretical explanation on the observed patterns, but their claim is mainly inferred from intuition without strong empirical evidence. Some of their data do not match other native speakers' judgments, and the vowel lengthening or shortening phenomena is now hard to accept as synchronic evidence, since most native speakers of Contemporary Seoul Korean no longer have the vowel length contrast.

The present study aims at providing a new approach to analyzing Seoul Korean prosody, filling the gaps found in both previous approaches. In the following sections, we provide results from a perception experiment, and based on the results, we propose that the preferred tonal patterns in the perception experiment are explained by an underlying metrical structure in Korean.

# 2 Perception experiment

## 2.1 Method

Since not all tonal patterns are observed in a production experiment, it is hard to see which tonal patterns are acceptable to native speakers from the results of a production experiment. Thus, we conducted a perception experiment to evaluate all possible tonal patterns. For the target words, we employed three loanwords, considering that previous studies have shown that speakers of many languages, including Korean, adapt a default metrical system when pronouncing loanwords (Hyman 1970; Kang 2011). The target words differed in the number of syllables (2, 3, and 4 syllables, respectively), and one male native speaker of Seoul Korean (age 34) produced all target words. After recording, the pitch contours of the target words were modified using *Praat* (Boersma & Weenink 2013) to generate all possible tonal patterns (4 patterns for the 2-syllable word, 8 patterns for the 3-syllable word, and 16 tonal patterns for the 4-syllable word). The L tone was set to 110Hz and the H tone to 140Hz (Figure 1). These target words were presented in a carrier sentence in (1), and each target word was evaluated three times.

(1) na nɨn ɾo ma / mi ču ɾi / ɾu ma ni a gam ni da
I Rome / Missouri / Romania go
'I go to Rome / Missouri / Romania.'

Ten native speakers of Seoul Korean participated in evaluating whether each tonal pattern sounded natural or not. The participants were students in their 20s, studying at a university in the US, who all reported that their length of residence in the US was no longer than one year. When evaluating the naturalness of the tonal patterns, the participants used a 7-point scale, where '1' means very unnatural, '4' means neither natural nor unnatural, and '7' means very natural. The experiment was carried out in a sound-attenuated sound booth, and all participants were paid appropriately.

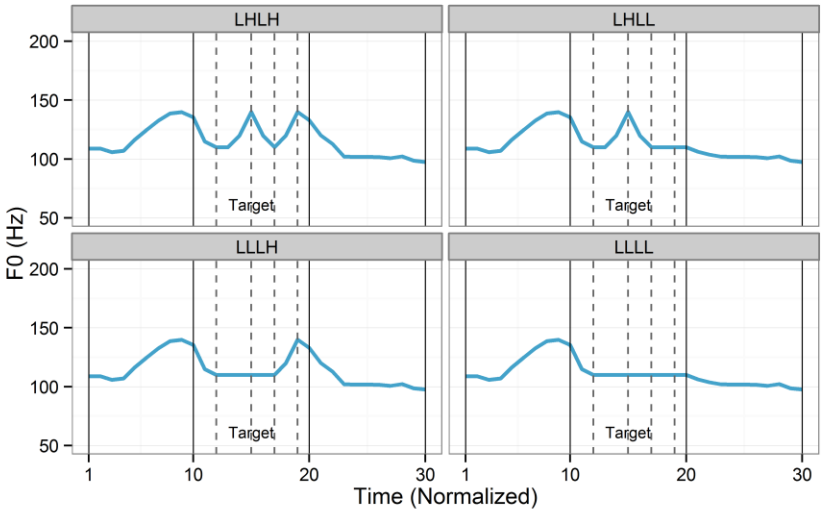


**Figure 1**. *Sample time-normalized F0 contours of the utterance Nanɨn ɾumania gamnida. The vertical lines show word boundaries, and the dashed lines show the pitch target of each syllable.*

## 2.2 Results

One-way ANOVA analyses reveal that the effect of the tonal patterns is significant for the target words ($p < .01$ for the 2-syllable word; $p < .001$ for the 3-syllable word; $p < .001$ for the 4-syllable word). This result suggests that the naturalness of tonal patterns in Seoul Korean heavily depends on how tones are aligned in an AP. Tukey's post-hoc analyses show that the tonal patterns in (2) are significantly different from the other tonal patterns within each target word. (The mean values of naturalness are provided in parentheses.) Note that the favored tonal patterns within each target word are not significantly different from one another.

(2) 2-syllable word: LL (4.5), LH (5.4)
3-syllable word: LHL (4.9), LLL (5.2), LHH (6.4), LLH (6.4)
4-syllable word: LHLL (5.6), LLLL (5.7), LHLH (6.0), LLLH (6.1)

There are several noteworthy points in the results of the perception experiment. First of all, all favored tonal patters do not start with a H tone. Also, the distribution of the H tone is more limited than that of the L tone in these patterns. These patterns have a H tone on the second syllable and/or on the final syllable, when they have one; otherwise, a H tone does not fall on any syllable (LL, LLL, LLLL). In addition, a sequence of more than two H tones is not favored. Only one favored tonal pattern has two H tones in a row (LHH), but other than that, H tones are less favored than L tones.

# 3 Discussion

The results of the perception experiment suggest an important aspect of the prosody in Seoul Korean. The H tone is more limited in its distribution than the L tone, and a H tone never falls on the first syllable. As the favored tonal patterns have shared properties, there must be a system in the grammar of Seoul Korean that regulates these tonal patterns. We conjecture that there is an underlying metrical system that is projected as a surface tonal pattern. In particular, we assume that Seoul Korean has iambic feet, considering that the participants of the perception experiment judged most H-starting tonal patterns as very unnatural and also considering that previous studies have argued Korean has an iambic system.

De Lacy (2002) analyzes patterns of stress-driven tone, where metrical structure determines the distribution of tones. In explaining the relationship between tone and stress, he shows that prosodic heads prefer a higher tone over a lower tone, while non-heads are more likely to attract a lower tone than a higher tone. In borrowing his framework, we assume that APs are basic prosodic units in Seoul Korean and tonal patterns of APs in Seoul Korean are based on an iambic system. Also, following his proposal, we suggest that foot heads in Seoul Korean also attract a H tone, but a H tone is prohibited on foot non-heads. The constraints we use in analyzing the favored tonal patterns are listed in (3).

(3) RHTYPE=I — Feet have final prominence (Kager 1999).
UNARY-R — Every non-branching foot is adjacent to the right edge (Buckley 2009).
PARSE-σ — Every syllable is contained inside a foot (Prince & Smolensky 1993).
*NONHD/H — Assign a violation for each occurrence of a high-toned foot non-head (de Lacy 2002).

| | |
|---|---|
| *HD/L | Assign a violation for each occurrence of a low-toned foot head (de Lacy 2002). |
| *H | Assign a violation for each occurrence of a high-toned syllable (Prince & Smolensky 1993; de Lacy 2002; among others). |

We rank the constraints on foot construction, both RYTYPE=I and UNARY-R, undominated to rule out any candidates with trochaic feet or unary feet aligned with the left edge of an AP. We also add PARSE-σ as one of the undominated constraints to eliminate candidates with unparsed syllables. Considering that Seoul Korean requires a foot non-head to be low-toned but does not require a foot head to be high-toned, we list *NONHD/H as undominated, whereas *HD/L is violable. Finally, we add *H, a cross-linguistically universal constraint, to the set of the dominated constraints. Combining all the constraints, we propose that the surface tonal patterns of an AP in Seoul Korean are governed by the constraint ranking in (4). As the favored tonal patterns are not significantly different from one another in the perception experiment, we suggest that the four undominated constraints are mutually unranked.

(4) RHTYPE=I, UNARY-R, PARSE-σ *NONHD/H » *HD/L, *H

The tableau in (5) demonstrates how the ranking works for a 2-syllable word.[1] Candidate (5c) critically violates RHTYPE=I, having initial prominence. Therefore, it is not selected even though it does not violate the other undominated constraints. Similarly, (5d) has a H tone on the initial syllable, which is not the foot head, violating *NONHD/H, and it is also ruled out. Finally, (5e) is not chosen as a harmonic output either, since the syllables are not parsed at all. Thus, (5a) and (5b), which violate one of the dominated constraints once, are selected.

(5) 2-syllable word: *ɾo ma* 'Rome'

| Input: /ɾo ma/ | RHTYPE=I | UNARY-R | *NONHD/H | PARSE-σ | *HD/L | *H |
|---|---|---|---|---|---|---|
| a. ☞ (ɾo$_L$ má$_H$) | | | | | | * |
| b. ☞ (ɾo$_L$ má$_L$) | | | | | * | |
| c. (ɾó$_L$ ma$_H$) | *! | | | | | * |
| d. (ɾo$_H$ má$_H$) | | | *! | | | ** |
| e. ɾo$_L$ ma$_H$ | | | | *!* | | * |

The same constraint ranking works for the 3-syllable word as well. See the tableau in (6). Candidate (6e) violates one of the undominated constraints, RHTYPE=I, so it is not selected as the optimal output. Also, (6f) has a unary foot at its left edge, violating UNARY-R crucially. Note that even though the initial tone is changed to L in (6f), it cannot be a winning candidate for having a unary foot at the left edge. (One of the winning candidates, (6b), shows a LLH tonal pattern, but it has a unary foot at the right edge.) Likewise, (6g) and (6h) are not the most harmonious candidates, because the final syllable in (6g) is a high-toned foot non-head and (6h) has one

[1] In every tableau of the present paper, an acute mark indicates a foot head, and tones are marked with subscript letters.

syllable unparsed. Therefore, candidates (6a-d), which do not violate the undominated constraints, win over the other candidates.

(6) 3-syllable word: *mi ču ɾi* 'Missouri'

| Input: /mi ču ɾi/ | RHTYPE=I | UNARY-R | *NONHD/H | PARSE-σ | *HD/L | *H |
|---|---|---|---|---|---|---|
| a. ☞ (mi$_L$ čú$_H$)(ɾí$_L$) | | | | | * | * |
| b. ☞ (mi$_L$ čú$_L$)(ɾí$_H$) | | | | | * | * |
| c. ☞ (mi$_L$ čú$_L$)(ɾí$_L$) | | | | | ** | |
| d. ☞ (mi$_L$ čú$_H$)(ɾí$_H$) | | | | | | ** |
| e. (mí$_H$ ču$_L$)(ɾi$_L$) | *! | | | | | * |
| f. (mí$_H$)(ču$_L$ ɾí$_H$) | | *! | | | | ** |
| g. (mi$_L$ čú$_H$)(ɾi$_H$) | | | *! | | | ** |
| h. (mi$_L$ čú$_H$) ɾi$_L$ | | | | *! | | * |

Lastly, the tableau in (7) shows how the constraints work to select the optimal candidates. Candidates (7a-d) do not violate any of the undominated constraints, so all of them are selected as the most optimal outputs. However, (7e), which has two unary feet, violates UNARY-R, since (ɾu) is not aligned with the right edge of the word. UNARY-R will rule out candidates with more than one unary foot, such as (7e) and (σσ)(σ)(σ), since only one unary foot can be aligned with the right edge of a word. Also, (7f) has trochaic feet, so it is ruled out for its violation of RHTYPE=I. Given that the mean value of the HLHL pattern was the lowest in the perception experiment (M=2.1), we can confirm that Seoul Korean strongly disfavors trochaic feet. In addition, (7g) is not chosen as an optimal output because it has two unparsed syllables. PARSE-σ eliminates all candidates with unparsed syllables, such as (σσ)σσ and (σσ)(σ)σ. Finally, (7h) is ruled out for violating *NONHD/H, since the foot non-head *ɾu* in (ɾu ma) has a H tone. Note that *NONHD/H successfully rules out any tonal patterns with more than two H tones, such as LHHH, HLHH, HHHL, and HHHH, because two feet is the maximum that a 4-syllable word can have without violating the other undominated constraints.

(7) 4-syllable word: *ɾu ma ni a* 'Romania'

| Input: /ɾu ma ni a/ | RHTYPE=I | UNARY-R | *NONHD/H | PARSE-σ | *HD/L | *H |
|---|---|---|---|---|---|---|
| a. ☞ (ɾu$_L$ má$_H$) (ni$_L$ á$_H$) | | | | | | ** |
| b. ☞ (ɾu$_L$ má$_L$) (ni$_L$ á$_H$) | | | | | * | * |
| c. ☞ (ɾu$_L$ má$_H$) (ni$_L$ á$_L$) | | | | | * | * |
| d. ☞ (ɾu$_L$ má$_L$) (ni$_L$ á$_L$) | | | | | ** | |
| e. (ɾu$_L$) (ma$_L$ ní$_H$) (á$_H$) | | *! | | | | ** |
| f. (rú$_H$ ma$_L$) (ní$_H$ a$_L$) | *! | | | | | ** |
| g. (ɾu$_L$ má$_H$) ni$_L$ a$_H$ | | | | *!* | | ** |
| h. (ɾu$_H$ má$_H$) (ni$_L$ á$_H$) | | | *! | | | *** |

# 4 Summary and conclusion

The nature of the prosody of Seoul Korean has been disputed in many previous studies. Some studies have provided empirical evidence that Seoul Korean has systematic phrasal tonal patterns, yet have failed to provide a theoretical explanation for the observed patterns. On the other hand, other studies have provided a theoretical explanation on several prosodic-related phenomena, yet they lacked empirical evidence to support their ideas. The present paper provided new evidence for the favored tonal patterns in Seoul Korean by conducting a perception experiment, and suggested that the favored tonal patterns reflect an underlying metrical structure of Seoul Korean. In particular, we propose that Seoul Korean has iambic feet, based on the finding of the perception experiment that all H-toned-starting tonal patterns are disfavored. The judgments in the perception experiment can be best explained by assuming that Seoul Korean has a metrical structure, which derives its surface tonal patterns.

The implication of the present study is that the previous approaches to Seoul Korean prosody are not opposed to each other, but rather they can be incorporated within the same framework. The present study bridges the gap in the literature by providing empirical evidence for favored tonal patterns and taking a theoretical approach to those patterns. Finally, we believe that this approach will reveal the nature of underlying mechanisms of the prosody of a language like Seoul Korean that would otherwise be difficult to assess.

# References

Boersma, Paul & David Weenink. 2013. *Praat: Doing phonetics by computer* [computer program]. Version 5.3.56. <http://www.praat.org/>.

Buckley, Eugene. 2009. Locality in metrical phonology. *Phonology* 26, 389-435.

de Lacy, Paul. 2002. The interaction of tone and stress in Optimality Theory. *Phonology* 19, 1-32.

Hyman, Larry M. 1970. The role of borrowing in the justification of phonological grammars. *Studies in African Linguistics* 1. 1-48.

Jun, Sun-Ah. 1993. The Phonetics and Phonology of Korean Prosody. Ph.D. dissertation. The Ohio State University.

Jun, Sun-Ah. 1998. The Accentual Phrase in the Korean prosodic hierarchy. *Phonology* 15, 189-226.

Jun, Sun-Ah. 2007. The intermediate phrase in Korean intonation: evidence from sentence processing. In C. Gussenhoven & T. Riad (Eds.) *Tones and Tunes: Studies in Word and Sentence Prosody* (pp. 143-167). Berlin: Mouton de Gruyter.

Kager, René. 1999. *Optimality Theory*. Cambridge: Cambridge University Press.

Kang, Yoonjung. 2014. Voice Onset Time merger and development of tonal contrast in Seoul Korean stops: A corpus study. *Journal of Phonetics, 45*, 76-90.

Ko, Eon-Suk. 1999. Interaction of tone and stress in Chonnam and Seoul Korean. *Proceedings of the 18th West Coast Conference on Formal Linguistics.* 246-259.

Ko, Eon-Suk. 2010. Stress and long vowels in Korean: Chicken or egg, first? *Japanese/Korean Linguistics 17*, 377-390. Stanford: CSLI.

Lee, H-B. 1989. *Korean Grammar*. London: Oxford University Press.

Prince, Alan and Paul Smolensky. 1993. *Optimlaity Theory: constraint interaction in generative grammar*. Ms., Rutgers University, New Brunswick and University of Colorado, Boulder.

Silva, David. 2006. Acoustic evidence for the emergence of tonal contrast in contemporary Korean. *Phonology, 23*, 287-308.