

EXPERIMENTAL PHONETIC STUDY OF THE SYLLABLE DURATION OF KOREAN WITH RESPECT TO THE POSITIONAL EFFECT

Hyunbok Lee and Cheol-jae Seong***

* Department of Linguistics, Seoul National University, Seoul, Korea

** Spoken Language Processing Section, Electronics & Telecommunications

Research Institute, Taejon, Korea

Hanslee@power1.snu.ac.kr / scj@zenith.etri.re.kr

ABSTRACT

The aim of this paper is to describe the prosodic structure of Korean related to the syllable duration varying with its positional difference. An attempt is made in this study to analyze and describe the concrete correlation between the syllable lengthening and its position in the utterance at the initial and final positions.

Using the syllable [na] at the final and initial position of a prosodic phrase in the Korean version of 'the North Wind and the Sun', it has found that the ratio of phrase final versus phrase initial syllable lengthening was approximately 1.8:1 for 4 subjects taking part in the test. In the case of nonsense data, we found that the ratio was approximately 1.6:1 for 2 out of 3 subjects.

The results of this study might indicate that Korean tends to have a high rate of final lengthening. We can tentatively classify it, therefore, as a stress-timed language. Still, there is no denying that further studies should be done before we can be absolutely certain about the classification of languages along the dichotomy scale.

1. INTRODUCTION

This paper describes the prosodic structure of Korean related to the syllable duration varying with its positional difference. An attempt is made in this study to analyze and describe the concrete correlation between the syllable lengthening and its position in the prosodic phrase at the initial and final positions.

As is well known, the typological classification of languages on the basis of rhythmic patterns was initiated by Pike(1945) and Abercrombie(1967). Thus two types of languages were established according to the degree of isochrony, i.e. stress-timed and syllable-timed languages. There may be various criteria for classifying a language as either of the two types. We can find relevant examples from Dauer(1983), Hoequist(1983), and Strangert (1985). With respect to these debates, it can be indicated that the durational ratio of final to initial syllable may play an important role in characterizing a language as one type or the other.

Some durational effects, which are coupled with both syllable

duration and its carried positions in target sentential units, have been named as initial and final lengthening. The fundamental causes of these effects have been described by many scholars.

Kim(1974: 133 - 134) explains it from a physiological viewpoint:

1) Pause can make such an effect that it causes psychological and physiological relaxation which, accordingly, may connect with the relaxation of articulatory muscles.

2) Duration and the force of articulation may show a reciprocal compensation. Lengthening of a final syllable may be yielded from an effort to compensate the smaller intensity of the syllable.

In a normal speech situation, the subglottal air pressure has a systematic relation with the change in F_0 and intensity in declarative sentence. In the beginning of a sentence where the subglottal air pressure is high, the F_0 and intensity are also high. Along with the decrease in the subglottal air pressure toward the end of the sentence, the fundamental frequency and intensity also decrease, the decrease becoming more rapid in the final one or two syllables. Finally, it can be observed that the final parts of sentential or phrasal units became longer than others. This may be explained by the durational compensation for the decrease of the energy of articulation.

Cooper(1976:recit. in Lindblom et al. 1981) proposes three approaches towards the final lengthening phenomena, which might be closely related to systematic process of syllable lengthening;

1) Phrase final lengthening offers an extra fraction of timing during which a following phrase can be planned.

2) Segments of a processing domain might be stored in a buffer which operates like a push-down store, containing a 'spring'-like mechanism. The force on the spring is directly proportional to the number of segments currently in storage. As a consequence, successive segments are emitted from the buffer at successively slower rates, and hence, possess successively longer durations.

3) Lengthening serves as a cue for the listener, who are responsible for perceiving the exact position of boundary. Klatt(1975) explains the possibility that prepausal lengthening

reflects the need for an extended duration during which there is sufficient time to produce a fundamental frequency contour signaling the continuation or termination of the phrase.

Lindblom et al.(1981) said that final lengthening effect has to do with an asymmetry of the space saving operations in Short Term Memory:

Events on their way out of STM, that is units that have been processed(preceding syllables) call for less space saving than events that are on their way in to be processed(following syllables)(Lindblom et al. 1981: 72).

Oller(1973) reported that English word final syllable has lengthening effect. In the experiment using nonsense words, it can be observed that stressed and nonstressed vowel duration were lengthened about 100 msec in final position from all of the 7 subjects. Compared with the consonantal duration which is confined to almost first position, the final syllable lengthening is observed as directly proportional to vowel lengthening.

Similar observations can be found in Gaitenby(1965) and Klatt(1975, 1976) that a word located in the sentence final position was about twice as long or even longer than the same one at initial position and the enhanced part was limited mainly to the vowel.

Delattre(1966) and Hoequist(1983) both argued that the ratios of final lengthening were so different across languages as to use as a cue for classifying languages along with language typology. In studies of Italian which is generally known as syllable-timed language, Bertinetto(1978) argued that there's no evidence of final syllable lengthening.

2. EXPERIMENT

2.1. Purpose

The ratio of the duration for final to initial syllable may vary across languages, so that it can be used as a typological evidence in the language diversity. We will apply this idea to Korean and compare the result with those of other languages in the following experiment.

2.2. Material

In this paper two different experiments have been carried out, the one using the 'sense data' based on the well-known fable 'the North Wind and the Sun(Korean version)' and the other the 'nonsense data' which has already been used by Kim(1974) for some other experimental purpose.

1) In the fable, we chose the same syllable [na] at initial and final position in two different prosodic phrases respectively. Prosodic phrase means a unit having a clear prosodic boundary at its final

position. Phonologically there's no durational difference between the two vowels of the target syllables.

{baram-gwa hennim-i/ seoro him-i deo seda-go/.../ nageune eui wethu-reul/.../ bukphung-eun himk'eot bureosna/ bulmyeon bulsurok/} * slash(/) means major boundary established by perceptual and acoustical way.

2) Nonsense data suggested by Kim(1974:120) was pronounced in the sentence frame. The material is as follows.

* sentence frame: /igeosi _____da/, which means 'this is _____.'

* material: manana

* target word: banana

2.3. Subject

4 male subjects in their mid 20s are students at Seoul National University. They have much talent in articulating the lab speech. They are abbreviated as psj, pcw, hsh, hdh respectively.

2.4. Procedure

Recording was progressed in sound proof room of Linguistics Department in Seoul National University. We used Unidyne III 545 D dynamic microphone of Shure Inc. The subjects repeated 9 times among which the first and last session were excluded. A/D was carried out in KAY CSL 4300 B program under the condition of 16 kHz sampling and 16 bit resolution. Speech analysis was also accomplished on CSL program.

The Statview program of Macintosh has been used or statistical analysis. Since the nonsense data of Kim(1974)'s had some problem that the consonants of first and final syllable were different each other, we only used the measurement of vowel duration. To compare these Korean data with those of foreign languages, the result of Hoequist(1983b)'s was quoted.

3. RESULT

(1) Syllable [na] in 'the North Wind and the Sun'

Using the syllable [na] at the final and initial position of two different prosodic phrases in the Korean version of 'the North Wind and the Sun', the ratio of phrase final versus phrase initial syllable lengthening was as follows.

sub.	initial[na]		final[na]	
	M	s	M	s
PSJ	137.943	19.832	280.929(2.037)	25.293
PCW	141.214	24.108	247.514(1.753)	13.99
HSH	160.343	13.049	246.057(1.535)	12.522
HDH	128.729	13.679	231.271(1.797)	11.3

Table 1. Comparison of syllable duration [na] in 'the North Wind & the Sun'(msec) M:mean, s:standard deviation, n=7, the number within parenthesis is ratio.

(2) Nonsense data [mananada] in Kim(1974)'s data

In the case of nonsense data [mananada], we found that the ratio of initial [a] to final vowel [a] was approximately 1.6:1 for 2 out of 3 subjects. One subject(sub.2) seemed to pronounce the material without any hesitation and at a very slow speech rate.

sub.	initial[a]		final[a]	
	M	s	M	s
sub.1	91.6	5.797	142.6(1.557)	14.607
sub.2	71.5	11.277	268.4(3.754)	30.215
sub.3	114.7	7.349	173.9(1.516)	14.556

Table 2: Comparison of vowel duration conditioned by positions in nonsense words(msec) M:mean, s:standard deviation, n=10, the number within parenthesis is ratio.

(3)The data of English, Spanish, and Japanese in Hoequist(1983b)

Hoequist(1983b) measured initial, medial, and final syllable duration at word level in English, Spanish, and Japanese respectively with a view to state that a language can be classified as a typical type according to the durational difference along with positional variance. He used reiterant nonsense data. We quoted the measurement of the duration of initial and final syllable among them.

inf.\position	initial	final
E1	167	247(1.479)
E2	175	225(1.286)
S1	183	256(1.399)
S2	264	320(1.212)
J1	149	191(1.282)
J2	138	167(1.210)

Table 3: Hoequist(1983b:214)- 'Effects of position of syllable duration(msec)' * The number in () is a ratio of final to initial syllable at word level * E: English, S: Spanish, J: Japanese

4. DISCUSSION

The ratio of phrase final versus phrase initial syllable lengthening of [na] in the Korean version of 'the North Wind and the Sun' was approximately 1.8:1 for 4 subjects. In the nonsense data, It was found that the ratio of initial to final vowel was approximately 1.6:1 for 2 out of 3 subjects.

We should have admitted some variations from the former case. Since the data were adopted from the mid part of a long passage and there were a major pauses before and after the target syllable, the result may differ from that of nonsense data. Furthermore, since the two target syllable [na]s are located in different word and also in different prosodic phrase respectively, some contextual difference between them should be taken into consideration. It will certainly guarantee a good experimental result when a notion of contextual sameness could be established under the experimental environment.

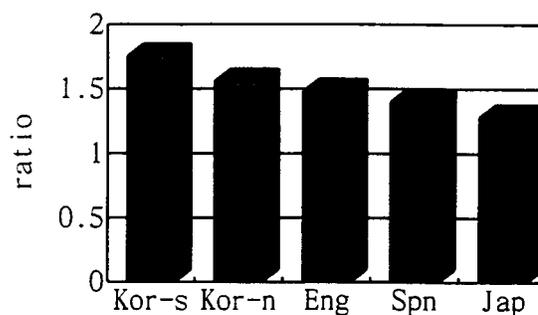


Figure 1: Comparison of the ratio of final lengthening across languages: Korean1(sense), Korean 2(nonsense), English, Spanish, Japanese.

Compared with the sense material, the nonsense data seem to be conditioned by a harmonized and ideal condition. At least by the establishment of identical experimental condition, it may be acknowledged that the result from nonsense data would be correct and more credible in the sense of environmental sameness.

However nonsense data may end up being nonsense as the name implies. Therefore we do think about the difference of time programming between real and artificial word. Nevertheless, nonsense material has been treated as an important device for proving a lot of experimental problems. This may be true in many cases. Kim(1974) and Hoequist(1983b), which were presented as a previous experiments above, also made use of the nonsense data to prove their hypotheses concerning durational aspect of a language.

The experiments carried out in this paper used both sense and nonsense data. These two kinds of approaches yielded somewhat different time ratios in Korean language. It should be borne in mind, however, that the former was measured in the entire syllable and the latter was confined to vowel duration. This may be responsible for producing such differences. But as previous works indicated that the lengthening phenomena might in general be strongly tied up with vowel and not consonant in a syllable, it may be better to accept that there may be no serious contrasts between the two. Thus, from the present experimental results, we may set up a typical durational model for Korean with respect to language typology.

For reference, we can quote the ratios suggested by some earlier studies. In Delattre(1966), which studied cases of English, German, Spanish, and French, the duration ratios between 'final' and 'non-final' syllables of those languages are: English(1.53:1), German(1.51:1), Spanish(1.17:1), and French (1.78:1). In Hoequist(1983:214), which examined the duration of initial, medial, and final syllable in English, Spanish, and Japanese, the duration ratios between final and initial syllable in nonsense words across languages are: Japanese(1.24:1), Spanish(1.31:1), and English(1.40:1).

The reason why the ratios examined by Hoequist(1983b) is different from Oller(1973), Klatt(1975, 1976), and Delattre(1966) seems to be inferred by the fact that in such case the nonsense data(reiterant of ma..)were used as experimental material.

Supposing that the results using sense words in English reflected much more of the speech reality, we can modify the English ratio from Hoequist(1983b) as leaning toward much higher one.

5. CONCLUSION

The results of this paper might indicate that if a language tends to have a high rate of final lengthening, we can classify it as a stress-timed language. Hoequist(1983b) and Delattre (1966) shows such a fact with an exact time ratios across languages. Still, there is no denying that further studies should be done before we can be absolutely certain about the validity of this criterion in the classification of languages along the dichotomy scale.

6. REFERENCES

1. Abercrombie, D., *Elements of General Phonetics*, Edinburgh University Press, 1967.
2. Bertinetto, M., "A Contrastive Study on the Production and Perception of Stress by English and Italian Speakers", *Conte, Ramat Sprache im Kontext*, Akten des 12, Linguistischen Kolloquiums, Pavia 2, pp. 79-92, 1977.
3. Cooper, W.E., *Syntactic Control of Speech Timing*, Ph.D. thesis, Psychology Department, M.I.T., 1975.
4. Dauer, R.M., "Stress-timing and Syllable-timing Reanalyzed", *Journal of Phonetics 11*, pp. 51-62, 1983.
5. Delattre,P.,"A Comparison of Syllable Length Conditioning among Language," *IRAL 4*, pp. 183-198, 1966.
6. Gaitenby, J., "The Elastic Word", paper given at 10th NCL 3.13, p. 12, 1965.
7. Hoequist. C.Jr., "Durational Correlates of Linguistic Rhythm Categories", *Phonetica 40*, pp. 19-31, 1983a.
8. _____, "Syllable Duration in Stress-, Syllable-, and Mora-timed Language", *Phonetica 40*, pp. 203-237, 1983b.
9. _____, "The Perceptual Center and Rhythm Categories", *Language and Speech 26-4*, pp. 367-376, 1983c.
10. Kim, K.O., *Temporal structure of spoken Korean*, Ph.D. dissertation, University of Southern California., 1974.
11. Klatt, D.H., "Interaction between Two Factors that Influence Vowel Duration", *Journal of the Acoustical Society of America 54-4*, pp. 1102-1104, 1973.
12. _____, "Vowel Lengthening is Syntactically Determined in a Connected Discourse", *Journal of Phonetics 3*, pp. 129-40, 1975.
13. _____, "Linguistic Uses of Segmental Duration in English: Acoustic and Perceptual Evidence", *Journal of the Acoustical Society of America 59*, pp.1208-1221, 1976.
14. Lee, H.B., *A Study of Korean(Seoul) Intonation*, MA thesis, University College London., 1964.
15. _____, "Korean Prosody:Speech Rhythm and Intonation", *Korea Journal Col.27 No.2*, Korean National Commission for Unesco, 1987.
16. _____, *Korean Grammar*, Oxford University Press, 1989.
17. Lindblom, B., Lyberg, B., and Holmgren, K., "Durational Patterns of Swedish Phonology, Do They Reflect Short Term Motor Memory Process ?", IULC, Bloomington, 1981.
18. Oller, D.K., "The Effect of Position in Utterance on Speech Segment Duration in English", *Journal of the Acoustical Society of America. 54-5*, pp. 1235-1247, 1972.
19. Pike, K., *The Intonation of American English*, Ann Arbor : University of Michigan Press, 1946.
20. Seong, C.J., *Experimental Phonetic Study of Korean Speech Rhythm*, Ph.D. dissertation, Seoul National University, 1995.
21. Strangert, E., *Swedish Speech Rhythm in a Cross-Language Perspectives*, Ph.D. thesis, Umea University, Stockholm, 1985.