

한국어 분류에 관한 음향음성학적 연구

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An acoustic study of word-timing with references to Korean

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Abstract

There have been three contrastive claims over the classification of Korean. To answer the classification question, timing variables which would determine the durations of syllable, word and foot were investigated with various words (/V-CV/, /VC-VC/, /VC-CVC/, /CV-CVC/, /CV-CVC-V-CV/, /CV-CVC-CV-CVC/) either in isolation or in sentence contexts using Soundcoup/16 on Macintosh P.C., and a total of 284 utterances, obtained from six Korean speakers, were used. It was found (1) that the durational pattern for words tended to maintain in utterances, regardless of position (1st/2nd foot), subjects and dialects (2) that the syllable duration was determined both by the types of phoneme and by the number of phonemes, the word duration both by the syllable complexity and by the number of syllables, and the foot duration by the word complexity, (3) that there was a contrastive relationship (negative/positive) between foot length in syllables and foot duration and (4) that the foot duration varied generally with word complexity if the same word did not occur both in the first foot and in the second foot. On the basis of these, it was concluded that Korean is a word-timed language where, all else being equal, including tempo, emphasis, etc., the inherent durational pattern for words tends to maintain in utterances. The main differences between stress timing, syllable timing and word timing were also discussed.

Key words: word timing, syllable duration, word duration, foot duration, Korean.

1. Introduction

The previous studies reveal that there are contrastive claims over the classification of Korean: (1) Korean is a syllable-timed language (Martin, 1951), (2) Korean is a stress-timed language (Lee, 1982, 1985) and (3) Korean is a word-timed language (Lee and Kim, 1991). The first claim was based on the impressionistic way of observation, and the data obtained from a Visi-Pitch for the second claim was limited to the level of words and phrases in isolation. Thus, the data obtained appeared to be improper for the claim since syllable timing or stress timing is related mainly to sentences. Although the investigation for the third claim was systematic, the claim was on the basis of the durational cues alone, relating to the word-initial/medial vowel segment.

In a spectrographic study (Lee and Kim, 1991), they investigated the effects of position in utterance on the duration of word-initial/medial vowel, using the key words 'pap' in the isolated long words and 'apa', 'ap'a', 'apha' in the frames: (1) "____ + neun ____" and (2) "____ + neun ____ + reul ____ han + ta" (where 'neun', 'reul' and 'ta' are endings). In the study, they found that (1) the duration of word-initial vowel was generally consistent, regardless of the position of the key words in utterances

and (2) the duration of word-medial vowel in the key word 'pap' varied significantly with its position in isolated long words: in the word 'khongpap', the vowel increment of word-final syllable arranged from 20 ms (i.e. 23%) to 54 ms (i.e. 64%), as compared with the word-initial vowel duration of the word 'papca.' On the basis of the findings, they tentatively hypothesized that Korean is neither a syllable-timed language (Martin, 1951) nor a stress-timed language (Lee, 1982), but a word-timed language where in normal speech (i.e. simple indicative statement) the inherent pattern of rhythm for a word tends to maintain, irrespective of its position in utterances. However, the data obtained, associated to the durations of the word-initial/medial vowel segment alone, were insufficient for the claim, since syllable/word durations are not related to the vowel segment alone, but both to syllable complexity and to word complexity, etc. Thus, a further systematic investigation is required to answer the question: "Do we group Korean to the language where French as a syllable-timed language is in, to the language where English as a stress-timed language is in, or to the word-timed language?"

In order to answer the question, I wanted to investigate the timing variables which determine the durations of syllable, word and foot with references

to Korean, using various words both in isolation and in sentences. In this study, stress is not my main concern since stress is not phonemic in Korean. Attentions will be confined to the following things:

(1) the effects on the syllable duration of phoneme and the number of phoneme, (2) the relationship between word length in phonemes and word duration, (3) the relationship between the foot length in syllables and foot duration. In Korean, foot is defined as a rhythmic unit which corresponds syntactically to a phrase.

Previous experimental studies of English, French, Swedish, etc. showed (1) that in stress-timed languages inter-stress intervals are not isochronous (Shen & Peterson, 1962; O'Connor, 1965; Faure, Hirst & Chafcouloff, 1980; Nakatani, O'Connor & Aston, 1981) and (2) that in syllable-timed languages syllables do not recur at regular interval (cf. Delattre, 1965; Roach, 1982; Wenk & Wioland, 1982; Nishinuma & Duez, 1989; Fletcher, 1991). Thus, as claimed by Fletcher (1991) and Wenk-Wioland (1982), there appears to be similarities between English and French both in interstress intervals and in the relationship between foot length in syllables and foot duration although some researchers (Lehist, 1977; Uldall, 1971) believe that a form of weak isochrony is present in English. However, Fant, et al. (1991) reported that French as a syllable-timed language showed the relative uniformity of syllable durations, as compared with English and Swedish as a stress-timed language and that syllable durations were closely related to syllable complexity and to degree of stress. They also claimed that the relative regular syllable intervals in French is due both to the predominance of CV units and to the lower degree of stress induced segmental lengthening and that in Swedish and English the concept of "stress timing" is attributed not to a physical isochrony but to the relative auditory prominence of stresses. This is agreeable somewhat with Dauer's claim (1983). In comparisons of data from continuous texts in English, Thai, Spanish, Italian and Greek, Dauer (1983) claimed that "the difference between stress-timed and syllable-timed languages has to do with differences in syllable structure, vowel reduction, and the phonetic realization of stress and its influence on the linguistic system."

2. Method

2.1. Subjects

Six speakers of Korean, two males and four females, served as subjects. One (i.e. the author) of the informants had a near Seoul accent, and the others had a Pusan accent. The Pusanian speakers were Pusan National University students in twenties. None of the speakers had any reported speaking problems.

2.2. Materials and procedures

The materials used in this study were constructed for each section. For the first section, two syllable words "a-pa" (nonsense word), "a-p'a" (daddy), and "a-pha" (pain) were constructed in isolation where /p/ indicates an unaspirated lax stop, /p'/ an unaspirated tense stop, and /ph/ an aspirated tense stop. The two syllable words also were inserted in the frame: "____do ____t'ara dari-da" where "do" was a subject ending to emphasize, "t'ara" an adverb ending (- according to), and "da" a verb or adjective ending. Thus, take for example, the "aphado apha't'ara dari-da" consisted of three feet: (1) aphado, (2) apha't'ara, and (3) dari-da, and it means "All pains are not the same", that is, "The degree of pain varies according to the types of pain." For the second section, the two syllable words "apa", "apal", "ilpəl" were constructed, and they were inserted in the frame "____do ____t'ara dari-da". For the third section, the words "apa", "ap'a", "apha", "saram" (man), "sigol-(country)apa", "sigolap'a", "sigolapha", "sigolsaram" were inserted in the frame "____do ____t'ara dari-da". For the first section, the isolated speech items were produced seven times, yielding a total of 84 utterances (3 (items) x 7 (repetitions) x 4 (subjects)), and the items in the frame were produced five times, giving a total of 60 utterances. For the second section, the sentence level speech items were produced five times, giving a total of 60 utterances (3 (items) x 5 (repetitions) x 4 (subjects)). For the third section, the speech items were produced five times, presenting a total of 80 utterances (8 (items) x 5 (repetitions) x 2 (subjects)). All speech items were pronounced at a normal speech rate, and a total of 284 utterances were used in this study. The constructed speech items for each section were randomly written in a list. Before the voices were recorded, the speakers were instructed to read the speech items two or three times at normal tempo as they usually speak. And the speakers read the speech items at normal tempo in the speech laboratory in the department of English language teaching, the Pusan National University, using a microphone and a tape recorder.

The durations of syllable, word and foot were measured on a Macintosh P. C., using both Soundscope/16 and Mac-Recorder. (1) The syllable duration in ms: for the word-initial syllable /a/ in the /VCV/ word in isolation, the interval from the onset of regular pulse to the beginning of sudden drop of the pulse in the voice signal which indicates the onset of the following stop consonant, and for the word-final /CV/ syllable, the interval from the onset of sudden drop of regular pulse to the offset of the regular pulse. (2) The word duration in ms: for the words "apa"-do/t'ara, "apal"-do/t'ara, "ilp'l"-do/t'ara, the interval from the onset of regular pulse to the onset of

sudden drop of regular pulse in the audio signal, and for the words "sigolsaram"-do/t'ara, "sigolapa"-do/t'ara, etc., the interval from the onset of hissing trace which indicates the onset of the word-initial /s/ to the onset of sudden drop of regular pulse for the following stop consonants.

(3) The foot duration in ms: for the foots "apa-do/t'ara", etc., the interval from the onset of regular pulse to the offset of regular pulse, and for the foots "sigolsaram-do/ t'ara", etc., the interval from the onset of hissing trace to the offset of regular pulse in the audio signal. Statworks was used on a Macintosh P. C. for the statistical analysis.

3. Results and Discussion

3.1. The effects on the syllable duration of phoneme and the number of phoneme.

At the level of isolated words.

As seen in Figures 1-4, in the isolated two-syllable words "a-pa", "a-p'a" and "a-pha", the durations of word-initial syllable and word-final syllable varied significantly with the types of intervocalic stops, regardless of subjects and dialects. Across subjects and dialects, the ratio between the mean durations of word-initial vowel /a/ followed by lax unaspirated stop /p/, tense unaspirated stop /p'/ and tense aspirated stops /ph/ was about 2 (116 ms) : 1 (64 ms) : 1 (66 ms). Thus, there was a significant left-to-right effect: the tense-stop induced durational shortening of preceding vowel. On the other hand, the mean duration of word-final /CV/ syllable with tense stops was longer by 53 % (160 ms) than with lax stop although there was small amount of interspeaker variabilities, and the mean ratio between

syllable duration was determined both by the types of phoneme and by the number of phonemes.

At the level of sentences.

In the first foot of sentences, the durations of word-initial syllable /a/ were shortened by average 31% in /a-pa/, 37% in /a-p'a/, and 32% in /a-pha/, as compared with the results obtained at the level of isolated words. On the other hand, the durations of word-final syllables (i.e. /-pa/, /-p'a/ and /-pha/) were decreased by 35%, 43%, and 42%, respectively. Thus, at the level of sentences both the durations of word-initial/final syllable were accompanied by a significant context induced decrease. However, the data obtained showed that in the first foot, the mean ratio between the durations of word-initial vowel /a/ followed by a lax unaspirated stop /p/, tense unaspirated stop /p'/ and tense aspirated stop /ph/ was about 2 (80 ms) : 1 (40 ms) : 1 (45 ms), and the mean ratio between the word-initial syllable duration and the word-final syllable duration was 1 (/a/) : 2.4 (/pa/), 1 (/a/) : 6.5 (/p'a/), and 1 (/a/) : 5.6 (/pha/). This was similar to the results in the second foot, and the durational pattern (i.e. the mean ratio) was generally similar to the case with the isolated words, irrespective of position (in the first/second foot) of the key words (see Figures 1-10). On the basis of the fact that the syllable duration varied significantly both with the types of phoneme and with the number of phonemes, one may infer that Korean is not a syllable timed language if, as claimed by Fant, et. al. (1991), syllable timing means that syllables recur relatively at regular intervals.

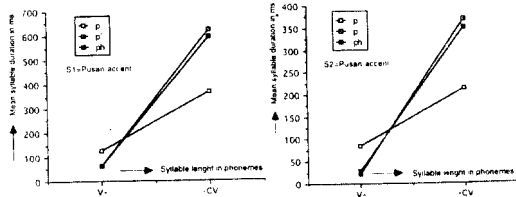


Figure 1. The effects of phoneme on the duration of syllable in isolated VCV words where V was /a/ and C a stop (n=7)

Figure 2. The effects of phoneme on the duration of syllable in isolated VCV words where V was /a/ and C a stop (n=7)

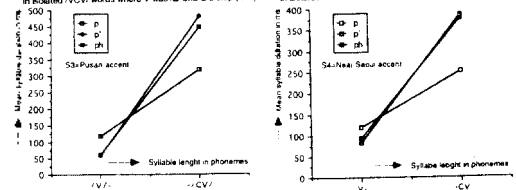


Figure 3. The effects of phoneme on the duration of syllable in isolated VCV words where V was /a/ and C a stop (n=7)

Figure 4. The effects of phoneme on the duration of syllable in isolated VCV words where V was /a/ and C a stop (n=7)

the word-initial syllable duration and the word-final syllable duration was highly significantly different with the types of stop: 1 (/a/) : 2.6 (/pa/), 1 (/a/) : 7 (/p'a/), and 1 (/a/) : 6.7 (/ph/). Thus, it appeared that the

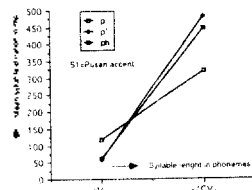


Figure 5. The effects of phoneme on the duration of syllable in the VCV words in the first foot of sentences where V was /a/ and C a stop (n=5)

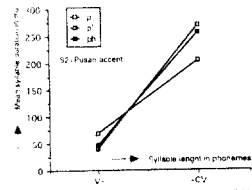


Figure 6. The effects of phoneme on the duration of syllable in the VCV words in the first foot of sentences where V was /a/ and C a stop (n=5)

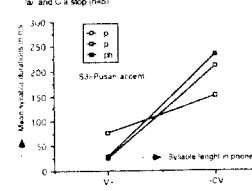


Figure 7. The effects of phoneme on the duration of syllable in the VCV words in the first foot of sentences where V was /a/ and C a stop (n=5)

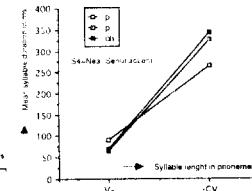


Figure 8. The effects of phoneme on the duration of syllable in the VCV words in the first foot of sentences where V was /a/ and C a stop (n=5)

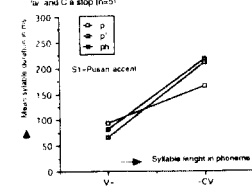


Figure 9. The effects of phoneme on the duration of syllable in the VCV words in the second foot of sentences where V was /a/ and C a stop (n=5)

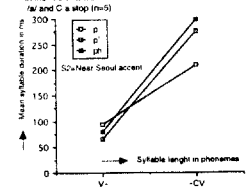


Figure 10. The effects of phoneme on the duration of syllable in the VCV words in the second foot of sentences where V was /a/ and C a stop (n=5)

3.2. The relationship between word length in phonemes and word duration.

As seen in figures 11-12, at the level of sentences word length in phonemes was positively related to word duration, regardless of speakers, dialects and position (in the 1st/ 2nd foot) although

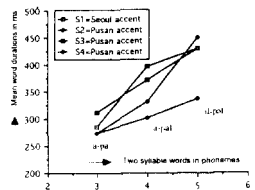


Figure 11. The relationship between word length in phonemes and word duration in the first foot of sentences. (n=5)

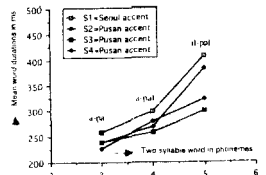


Figure 12. The relationship between word length in phonemes and word duration in the second foot of sentences. (n=5)

there were between-speaker variabilities. In the first foot, the average (i.e. across subjects and dialects) durations of two syllable words with four phonemes and five phonemes were increased by 15% (46 ms) and 39% (115 ms), compared with the word duration with three phonemes (see Figure 11), and in the second foot the durational increase was 13% (33 ms) and 47% (114 ms), respectively. Thus, although there were a tense stop (the second foot ending-initial segment) induced shortening effect on the preceding vocalic segments and a second foot-related shortening effect (see Figure 12), in general, the greater the number of phonemes in word, the longer the duration of the word, regardless of position and dialect. Considering this and the fact that word consists of syllables, one may infer that the word duration is determined generally by (1) the number of phoneme, (2) the number of syllable and (3) the types of phoneme.

3.3. The relationship between foot length in syllables and foot duration

As seen in Figures 13-14, the first foot duration and the second foot duration were insignificantly different, regardless of dialect although the first foot had a mono-syllable ending "do" and the second foot had a bi-syllable ending "t'ara". Contrasted with this, the Figures also showed that the foot length in five and six syllables were highly significantly longer than in three and four syllables, irrespective of dialects, position, and the ending length in syllables. Thus, there was a contrastive relationship (negative/positive) between foot length in syllables and foot duration although there was a second foot induced shortening effect. The foot duration varied mainly with word complexity unless the same word occurred in both

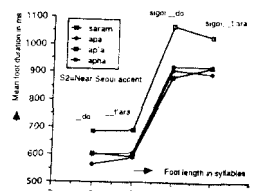


Figure 14. The relationship between foot length in syllables and foot duration in ms at the level of sentences where 'do' and 't'ara' are endings. (n=5)

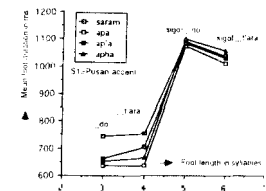


Figure 13. The relationship between foot length in syllables and foot duration in ms at the level of sentences where 'do' and 't'ara' are endings. (n=5)

foots (1st/2nd).

Considering the facts that we have observed so far, one may arrive at a conclusion that Korean is neither a syllable timed language as French nor a stress timed language as English and Swedish, but a word timed language where in normal speech the inherent durational pattern for word tends to maintain in utterances. In other words, all else being equal, including tempo, emphasis, etc., the inherent durational pattern for the word of Korean tends generally to maintain in utterances, regardless of position and dialect. The maintenance of the inherent durational pattern for word in sentences may due mainly to the facts (1) that stress is not phonemic in Korean, (2) that in Korean there is not either sentence stress induced segmental lengthening/shortening or unstressed syllable-related consonant/vowel deletion in certain contexts and (3) that there is no consonant deletion rules as in French for CV units. Stress timing in English may have something to do both with the sentence stress induced segmental lengthening/shortening and with the unstressed syllable-related consonant and vowel deletion in certain contexts, both of which are related to the relative auditory prominence of stresses. On the other hand, as pointed out by Fant, et. al. (1991), syllable timing seems to be attributed both to [the consonant deletion for] the predominance of CV units and to the lower degree of [sentence] stress induced segmental lengthening.

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References

Dauer, R. M. (1983) Stress-timing and syllable-timing reanalyzed, *Journal of Phonetics* 11, 51-62.
 Delattre, P. (1965) A comparison of syllable-length conditioning among language, *IRAL*, 7, 295-325.
 Fant, G., Kruckenberg, A. and Nord, L. (1991) Durational correlates of stress in Swedish, French and English. *Journal of Phonetics*, 19, 351-365.
 Faure, G., Hirst, D. J. & Chafcouloff, M. (1980) Rhythm in English: Isochronism, pitch, and perceived stress. *The Melody of Language*, (L. R. Waugh and C. H. Van Schooneveld, eds). 71-79. Baltimore: University Park Press.
 Fletcher (1991) Rhythm and final lengthening in French. *Journal of Phonetics*, 19, 193-212.
 Lee, H. B. (1982) An acoustic study of rhythm in Korean, *Phonetics* 4, the Phonetic Society of Korea, 31-48.
 Lee, H. B. (1985) A visi-pitch analysis of rhythm properties with references to Korean, English and french, *Phonetics* 9-10, the Phonetic society of Korea, 6-20.

- Lee, H. B. and Kim, D. W. (1991) The effect of position in utterance on the duration of segment in Korean, *Linguistic Journal of Korea* 16-1, 95-107.
- Lehiste, I. (1977) Isochrony reconsidered, *Journal of Phonetics*, 5, 253-264.
- Martin, S. E. (1951) Korean Phonemics, *Language* 27, 519-532.
- Nakatani, L. H., O'Connor, K. D. & Aston, C. H. (1981) Prosodic aspects of American English speech rhythm. *Phonetica*, 38, 84-106.
- Nishinuma, Y. & Duez (1989) Perceptual optimization of syllable duration in short French sentences. Paper presented at EUROSPEECH 89, Paris.
- O'Connor, J. D. (1965) The perception of time intervals. *Progress Report* (Phonetics Laboratory, University College London), 2, 11-15.
- Roach, P. (1982) On the distinction between stress-timed and syllable-timed languages. In *Linguistic Controversies* (D. Crystal, editor) 73-79. London: Edward Arnold.
- Shen, Y. & Peterson, G. G. (1962) Isochronism in English. *University of Buffalo studies in Linguistics, Occasional Papers*, 9, 1-36.
- Uldall, E. (1971) Isochronous stresses in R.P. In *Form and substance* (E. Hammerich, editor), Copenhagen.
- Wenk, B. & Wioland, F. (1982) Is French really syllable-timed? *Journal of Phonetics*, 10, 193-216.