

The Prosodic Behavior of Connective Ending '-ko' in Korean

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1. Introduction

The aim of this study is to describe the prosodic features of connective ending '-ko' in Korean. In doing so, I would like to explore the relationship between syntactic aspects and prosodic aspects of speech. The results of this study will establish the fundamentals for the synthesis of more natural-sounding speech sound.

Section 2 presents different classifications of '-ko' and the classification of '-ko' adopted in this study.

Section 3 presents the experiment.

Section 4 shows the results and discussion.

The final section presents summary and shows the topics for further study.

2. Connective ending '-ko' in Korean.

Classification of the connective ending '-ko' is a controversial matter. Each scholar has his own views. In 2.1., I show the classifications by some scholars.

2.1. Classifications of '-ko'

Kim(1970) and Kim(1977) viewed '-ko' as sequential occurrence.

1) *chayk-ul ilk-ko tokhwukam-ul ss-ess-ta.*

book-Acc read-Conj impression of book-Acc write-Past-Dec¹

'I read a book, and wrote my impressions of it.'

1) The abbreviations used are: Acc=accusative, CE=connective ending, Conj=conjunction, Dec=declarative, Loc=locative, Nom=nominative, Pres=present tense, Past=past tense, Top=topic.

Nam(1978, 1980, 1994) and Jeon(1984) considered 'sequential occurrence' as one of 'enumeration's. Namely, they divided 'enumeration' into temporal and spatial enumeration, and they regarded 'sequential occurrence' as temporal enumeration.

- 2) *ku-nun chakha-ko kongpu-to calhan-ta.*
 he-Top nice-Conj studies-Acc be good at-Dec.
 'He is nice and good at his studies.' (spatial enumeration)
- 3) *Yengswu-ka apeci-kkey kkujcwung-ul tut-ko cip-ul naka-ss-ta.*
 Yengswu-Nom father-source be scolded-Conj house-Acc leave-Past-Dec.
 'Yengswu had been scolded by his father and so he left.' (temporal enumeration)

On the other hand, Sung(1972) regarded 'sequential occurrence' as 'perfective event'.

Suh(1985) divided '-ko' into 'coordination, sequential conjunction, cause, manner, idiomatic expression'.

- 4) *say-ka wul-ko kkoch-i phi-n-ta.*
 bird-Nom sing-Conj flower-Nom bloom-Pres-Dec.
 'Birds are singing and the flowers are blooming.' (coordination)
- 5) *ku-nun son-ul ssis-ko pap-ul mek-nun-ta.*
 he-Top hand-Acc wash-Conj rice-Acc eat-Pres-Dec.
 'He washes his hands and then he eats.' (sequential conjunction)
- 6) *ku ai-ka i yak-ul mek-ko pyeng-i*
 the child-Nom this medicine-Acc take-Conj illness-Nom
na-ass-ta.
 recover-Past-Dec.
 'The child took this medicine, then he got better.' (cause)
- 7) *na-nun cha-lul tha-ko cip-ey ka-ss-ta.*
 I-Top car-Acc take-Conj house-Loc go-Past-Dec.
 'I went home by a car.' (manner)
- 8) *ku-nun chayk-ul ilk-ko iss-ta.*
 he-Top book-Acc read-CE exist-Dec.
 'He is reading a book.' (idiomatic expression)

Although there are several views regarding the classification of '-ko', they agree that '-ko' itself doesn't have any special meaning. The meaning of the sentence that includes '-ko' depends on the clause (predicate) that precedes '-ko' and the clause (predicate) that follows it. In short, '-ko' expresses the meaning of 'enumeration, perfective statement, cause' in semantic aspects, it has a connective function (coordinate or subordinate) and leads the auxiliary verb as a connective ending following main verb stem in syntactic

aspects.

Here I have followed Nam(1994) and Yi(1996), and I divided connective ending '-ko' into 'coordinate, subordinate and auxiliary' connective endings. Further explanation is presented in next subsections.

2.2. Coordinate connective ending '-ko'

Coordinate connective ending '-ko' connects clauses, phrases or words coordinately. Each constituent that is connected by '-ko' has equal status and functions. An alternation of the order of the constituents does not change the meaning of the whole sentence.

- 9a) *akwungi-eyse-nun thongcangcakpul-i hwalhwal tha-ko soysoth-eyse-n*
 fireplace-Source-Top firewood-Nom vigorously burn-Conj kettle-Source-Top
khephisayk yesmul-i selsel kkulh-ess-ta.
 coffee colored taffy liquid-Nom simmer-Past-Dec.
 'Firewood burnt vigorously in a fireplace and taffy liquid simmered in a kettle.'
- 9b) *sinlok-un ece-pota-to hanchung te kkaykkusha-ko sinsenha-ko*
 Green leaves-Top yesterday than more clean-Conj fresh-Conj
sayngkiissnun tusha-ta.
 alive seem-Dec.
 'Green leaves look cleaner, fresher and more alive than yesterday.'

In 9a), '-ko' connects clause and clause, in 9b), '-ko' connects predicate and predicate.

2.3. Subordinate connective ending '-ko'

Subordinate connective ending '-ko' connects each of the constituents subordinately. The preceding clause becomes the cause of the following clause, or the first event precedes the second event temporally. Accordingly, if the order of constituents connected by '-ko' is alternated, a sentence has different meaning (see 10a, b) or becomes nonsense. (see 11 a, b)

- 10a) *ku-nun son-ul ssis-ko i-lul takk-ass-ta.*
 he-Top hand-Acc wash-Conj teeth-Acc brush-Past-Dec.
 'He washed his hands and brushed his teeth.'
- 10b) *ku-nun i-lul takk-ko son-ul ssis-ess-ta.*
 he-Top teeth-Acc brush-Conj hand-Acc wash-Past-Dec.
 'He brushed his teeth and washed his hands.' (different meaning)
- 11a) *ku-nun swuto-lul thul-ko son-ul ssis-ess-ta.*
 he-Top tap-Acc turn on-Conj hand-Acc wash-Past-Dec.

'He turned on the tap and then washed his hands.'

11b) **ku-nun son-ul ssis-ko swuto-lul thul-ess-ta.*

he-Top hand-Acc wash-Conj tap-Acc turn on-Past-Dec.

'He washed his hands and then turned on the tap.' (nonsense)

2.4. Auxiliary connective ending '-ko'

This '-ko' connects a main verb and an auxiliary verb. This group includes '-ko issta', '-ko nata', '-ko malta', '-ko pota' and so on. I include the quotation ending, '-lago hata, -tago hata' into this group.

12) *i nal-un sonye-ka cingkemtali hankawunte anca*
 this day-Top girl-Nom stepping stones in the very middle of sit
seyswu-lul ha-ko iss-ess-ta.
 wash her face-Acc do-CE exist-Past-Dec.

'This day the girl was washing her face sitting in the very middle of the stepping stones.'

All kinds of ending '-ko' have the same phonetic realization in sentences, although they have different prosodic behaviors and syntactic functions.

3. Experiment

3.1. Materials

I didn't make sentences specially for this study. The reason is that the subjects, on account of repeating the same style of sentences in the recording list, usually become aware of which phonetic phenomenon is under investigation in the experiment. In this case, utterance of subjects is not natural. Preventing this unnaturalness, I used material recorded by KBS (Korean Broadcasting System) announcers in read speech. KBS announcers have read the texts from the textbooks used in elementary school, citations from the novels and news scripts. There are 615 sentences in the material. Out of 615 sentences, 299 sentences have '-ko'.

3.2. Subjects

The subjects were 10 male and 4 female announcers of standard Seoul Korean.

3.3. Procedure of signal analysis

Multi-Speech 3700 by KAY was used to analyze the materials. All sentences were pre-segmented and labelled at the level of phoneme. The duration, F0 and the energy of '-ko' in 299 sentences in total and the syllables immediately preceding and following '-ko' were measured. In case of F0 and energy, I measured the vowel portion of syllable. The most important criterion was the shape of the sound wave, the second criterion was the spectrogram and the third one was the judgement of the researcher based on auditory qualities. The starting point of the vowel segment was from the point where the second formant appeared.

4. Results and Discussion

4.1. Acoustic features of '-ko'

Table 1 shows the frequency of occurrence of each ending '-ko'.

table 1. Occurrence frequency of each '-ko'.

coordinate '-ko' (from here on "CO")	subordinate '-ko' (from here on "SUB")	auxiliary '-ko' (from here on "AUX")	Total
94	85	99	278

Next I present the acoustic features of '-ko'.

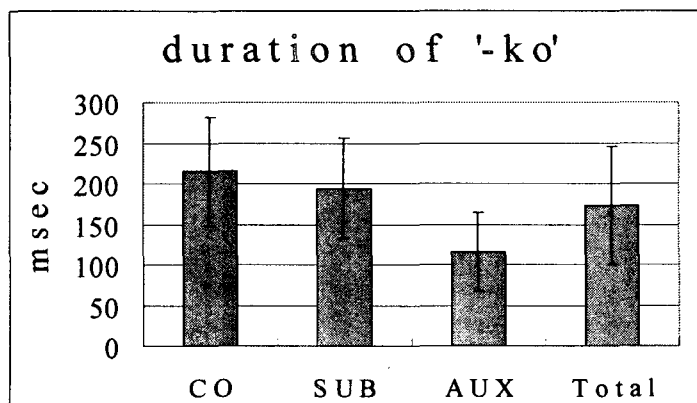


fig. 1. Duration of '-ko'.

table 2. Duration of '-ko'. (msec)

	CO	SUB	AUX	Total
mean	214.5	194	115.8	172.8
s.d.	67.5	61.7	48	73.6

As figure 1 and table 2 show, the order according to the duration of each group is CO > SUB > AUX. In order to examine whether this difference is significant statistically, one-way ANOVA was performed taking syntactic classification as an independent variable and the duration of '-ko' as the dependent variables. Syntactic effects of duration were significant ($F(2, 275) = 74.951, p < 0.05$).

Post-hoc test showed that the three groups are distinct.

table 3. Results of one-way ANOVA and post-hoc test.

Acoustic feature	F	sig.	post-hoc test
Duration	$F(2, 275)=74.951$	0.000	1 / 2 / 3
F0	$F(2, 275)=0.008$	0.923	-
Energy	$F(2, 275)=1.449$	0.24	-

* '/' in post-hoc test indicates groupings among '-ko'es.

In case of F0 and energy, male and female speakers were measured separately. Here are the results.

table 4. F0 of '-ko' for male speakers. (Hz)

	CO	SUB	AUX	Total
mean	100.1	98.9	100.8	100.0
s.d.	24	29	20	24.1

table 5. F0 of '-ko' for female speakers. (Hz)

	CO	SUB	AUX	Total
mean	160.2	147	161.3	156.8
s.d.	54.6	22.3	28.3	38.2

table 6. Energy of '-ko' for male speakers. (dB)

	CO	SUB	AUX	Total
mean	66.5	66.5	64.4	65.7
s.d.	6.6	7.8	7.4	7.3

table 7. Energy of '-ko' for female speakers. (dB)

	CO	SUB	AUX	Total
mean	68.6	67.3	68.7	68.3
s.d.	5.6	4	3.9	4.6

In case of F0, the order is AUX > CO > SUB for both male and female speakers, but it is not significant statistically. Also, there was no prominent statistical difference between CO, SUB and AUX group in Energy. (see table 3.)

4.2. Pause

Next, I examined whether subjects made a pause after ending '-ko' or not. The judgement was based on auditory qualities and then verified through the analysis of the waveform. The pause was judged to be present wherever the silence exceeded 30msec.

Subjects hardly ever made a pause after the auxiliary connective ending '-ko'. This is because the constituents that are connected by '-ko' that is, the main verb + auxiliary verb, are connected more strongly compared to other two groups, where '-ko' connects the constituents that have similar functions. In case of 6% of AUX group which have a pause, the sentences are relatively long. So, if the sentence is relatively long, subjects may make a pause, even after auxiliary connective ending '-ko'.

table 8. Occurrence ratio of pause.

	CO	SUB	AUX
ratio (%)	70.2	64.7	6.1
	(66/94)	(55/85)	(6/99)

* numbers in parenthesis indicate number of items that occurred with a pause vs total number of items.

4.3. Acoustic features of '-ko' compared to those of the neighboring syllables.

Next, I investigated the acoustic features of '-ko' compared to those of the neighboring syllables. I measured the preceding and the following syllables of '-ko'. In the following

example and the table, A indicates the preceding syllable while B indicates the following one. In fact, B stands for the first syllable of the word following '-ko'.

The examples are the same as those of section 2.

9a) *akwungi-eyse nun thongcangcakpul-i hwalhwal tha(A)-ko soy(B)soth-eysen khephisayk yesmul-i selsel kkulh-ess-ta.*

'Firewood burnt vigorously in a fireplace and taffy liquid simmered in a kettle.'

table 9. Comparison of duration of '-ko' and its neighboring syllables. (msec)

	syllable A	'-ko'	syllable B	comparison of duration
CO	150.1 (45.1)	214.5 (67.5)	192.1 (84.5)	'-ko' > B > A
SUB	140.5 (50.9)	194 (61.7)	159.5 (63.9)	'-ko' > B > A
AUX	127.6 (49.1)	115.8 (48)	109.2 (58)	A > '-ko' > B

* numbers in parenthesis indicate standard deviation.

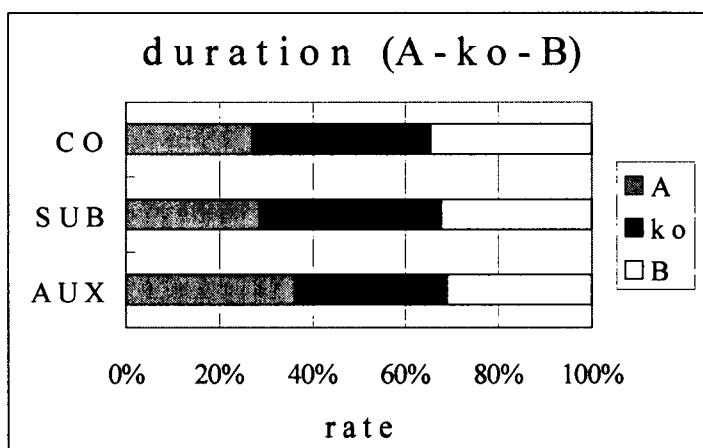


fig. 2. Ratio of duration A-ko-B.

As you can see in figure 2, in case of the CO and SUB, '-ko' is longer than other syllables. It might be related to the 'final syllable lengthening'. In case of AUX '-ko', as I explained in section 4.2., constituents are connected closely. Therefore, AUX '-ko' hardly ever lengthens, rather the preceding syllable, A, is longer than '-ko'.

Next are the results of F0 and energy.

table 10. F0 '-ko' and its neighboring syllables for male speakers. (Hz)

	A	'-ko'	B
CO	98.2(25.3)	100.1(24)	112(27.4)
SUB	100.9(23.5)	98.9(29)	107.7(27.1)
AUX	98.5(25.6)	100.8(20)	90.7(20.9)

* numbers in parenthesis indicate standard deviation.

table 11. F0 '-ko' and its neighboring syllables for female speakers. (Hz)

	A	'-ko'	B
CO	167.7(39.5)	160.2(54.6)	186(63.1)
SUB	162.4(22.6)	147(22.3)	186.9(28.4)
AUX	174.1(28.8)	161.3(28.2)	158.5(24.2)

* numbers in parenthesis indicate standard deviation.

For male and female speakers, in case of AUX '-ko', the following word starts at a lower pitch than '-ko', namely, B is lower than '-ko'. On the other hand, the following word starts at a higher pitch than '-ko' in other two types of '-ko'. Table 12, fig. 3 and 4 summarize the results.

table 12. Changes of pitch comparing to '-ko' and the results of t-test. (p<0.05)

	Changes of pitch comparing to '-ko'			
	male	sig.	female	sig.
CO	12% increase	0.014	16% increase	0.05
SUB	11% increase	0.134	13% increase	0.000
AUX	10% decrease	0.008	2% decrease	0.644

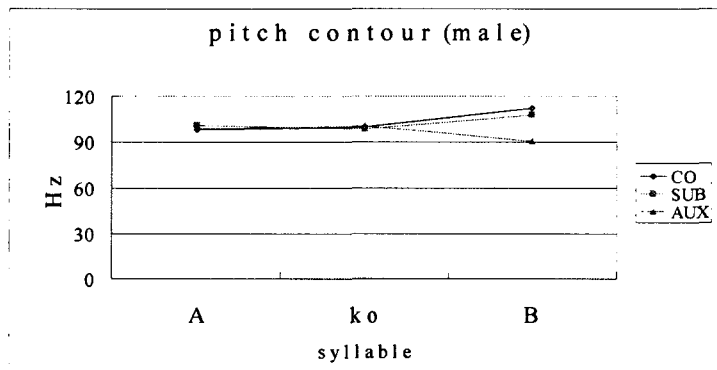


fig. 3. Pitch contour A-ko-B for male speakers.

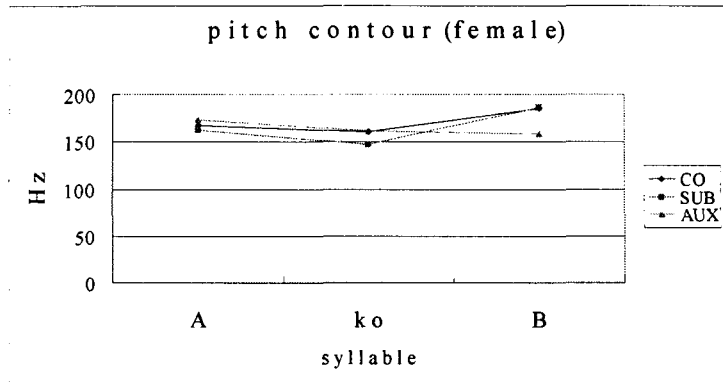


fig. 4. Pitch contour A-ko-B for female speakers.

5. Conclusion and Further Study

In this paper, the prosodic status, i.e. acoustic features and the relations to preceding and following syllables, of Korean connective ending '-ko' was investigated focusing on the syntactic aspects in read style. Connective ending '-ko' was divided into 3 groups, which are coordinate, subordinate and auxiliary '-ko'. In duration, CO '-ko' is the longest, next is SUB, and AUX. It is significant statistically. Post-hoc test showed that three '-ko's belong to different groups.

After ending '-ko', subjects made a pause about 70% of all cases in CO and SUB '-ko', however, there were only a few cases of after AUX '-ko'.

As a result of investigating acoustic features of '-ko' compared to those of the neighboring syllables, it is ascertained that '-ko' is the longest, then there is syllable A, and the shortest is B in CO and SUB '-ko'. In the case of AUX '-ko' is the longest is A, then '-ko', and B. Especially, 'word final lengthening' in CO and SUB was observed. Besides after coordinate and subordinate '-ko', the following syllable becomes high. On the other hand, after auxiliary '-ko', the following syllable becomes low.

The good topics for future research are as follows.

- 1) What is the influence of the neighboring phonemes on the prosodic features of '-ko'?
- 2) In this paper, CO and SUB '-ko' showed no difference, but, how can we differentiate both types of '-ko'?

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