

# A Prosodic Analysis on the Korean Subjective Particles

## -With Reference to the Establishment of Acoustic Features-

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### Abstract

This study aims to describe a prosodic pattern on the Korean subjective particles with respect to their discourse function. 4 kinds of Korean subjective particles were mainly investigated with reference to sentential location, grammatical relations that precede or follow the word including subjective particles, and prosodic phrasing. F0 and energy were gradually diminished as the particles moved down to the sentential final position. 'Ga' particle, which has been potentially regarded as having a grammatical focusing function, looks like to show relatively higher F0 in sentential medial in discourse. At sentential medial position, when the words including 'ga, eun, and neun' particles were preceded by adverbials, the acoustic variables of particles tended to be diminished by some ratio in comparison with the mean value. The duration of particles might vary with respect to style variation and especially that it tended to diminish from 150 basic, 50 separate, and finally 50 discourse successively. And there's some specific phenomenon that prosodic phrasing itself was relatively easily taken place after 'eun' and 'neun' particles. Finally, I tried to catch the prosodic characteristics (which would be established as acoustic features) of inter-word position at which specific subjective particles were intervened. These acoustic features can be made up of the duration and F0 fluctuation activated in the successive 3 syllables in which word (or prosodic) boundary was located.

*Keywords:* Discourse, Prosodic phrasing, Duration, F0

## 1. Introduction

This study aims to describe a prosodic pattern on the Korean subjective particles with respect to their discourse function for the purpose of getting more natural rules for speech synthesis. 'Discourse' can be explained that a continuous utterance composed of dynamic linguistic process in which the speaker or hearer want to send some

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information or intend by means of language in context[2]. A concept of grammar for discourse analysis has to be extended from sentential grammar, so that the relevant scope might cover from sentence to paragraph or entire text. Theories related to speech act or level can be comprehended in this respect. More details seem likely to be expressed by some discourse grammar including topic/focus, ellipsis, presupposition, and implicature[2].

The grammatical topic and focus related to the realization of the old and new information have been studied with the 4 kinds of particles (eun/neun: i/ga) in

case of Korean. Lots of grammarians in Korea have been regarding the particles 'eun/neun' as a special one having a function of topicality and contrast. Relatively, the particles 'i/ga' have been treated as having the grammatical focus.

Although there is some possibility of sharing common syntactic function as representing subjectivity in 4 subjective particles, they can show different prosodic behavior with respect to its own discourse function. This study, thus, has mainly focused to the prosodic characteristics of referred particles themselves, which were to be mainly investigated with reference to the sentential location, grammatical relations that can precede or follow the word including subjective particles, making prosodic phrase[2-4], and finally the correlation between syntactic structure and prosodic phrase. The prosodic phrase, here, is similar to the one presented as intonational phrase (boundary) suggested by Pierrehumbert[7], Beckman & Pierrehumbert[1], and Jun[5]. In Seong[8], it was defined as the unit which has evident break at its end in perceiving manner. In terms of engineering field, it might be the notion of major boundary in contrast to the minor one.

## II. Experiment

### 2.1. Material

On the basis of predicate\_complement relationship, we proposed 15 fundamental sentence types in Korean. A discourse text was consisted of 5 paragraphs, each of which has 10 sentences. As a result, We have made 1) 150 basic sentences through the manipulation of the 15 basic types (15\*10), 2) 50 separate sentences modified from the 150 basic sentences by using discourse grammars including anaphor, exchange of particles, and word order change, 3) and 50 continuous sentences constructing a unified story line, the content of which is the same as 2).

The content of discourse is as follows, which is paraphrased to Roman alphabet.

Younghee-wa Seokho-ne zip-eun han dongne-e iss-eoss-da.

Geu dongne-eui soop-eseoneun sansae-ga zeulgeopge zizeogwi-eoss-da. Geurigo, osolgil ga-eneun deulk'och-I pieo iss-eoss-da. Younghee-ga isa on hu eolma dwezi anaseo, Seokho-wa Younghee-neun chinggu-ga dwe-eoss-da. Younghee-neun azu sangnyangha-go, Seokho-neun daedanhee chinzeolhaess-da. Younghee-egeneun namdongsaeng-I hana iss-da. Geureonde, Seokho-neun yeodongsaeng-I se myeong iss-da. Younghee-neun eumak-eul zohahan-da. Geurigo, dokseo-neun Seokho-eui chwimi-ida. Seokho-wa Younghee-neun seoro mani biseuthaess-da.

Eoneu nal, Younghee-ga Seokho-ege soseol soseol chaek han gwon-eul seonmulhaess-da. Churi soseoli-eoss-da. Seokho-neun nal-I saeneun zuldo moreugo geu chaek-eul yeolsimhee ilgeoss-da. Geu soseol-eun mudeoun yeoreum bam-eul seoneulha-ge sikyeo zueoss-da. Geu daeum nal, Seokho-neun Younghee-ege geu soseol-eui naeyong-eul iyagihae zueoss-da. Geurigoneun Younggee-egedo geunyeoga zoaha-neun eumak CD-reul zu-eoss-da. Zip-euro darawaseo Younghee-neun geu eumak-eul deul-eoss-da. Seokho-ege zeonhwa-reul haeseo gomapda-neun mal-eul zeonhaess-da. Geu hu Younghee-neun geugeos-eul zasin-I gazang a k' i-neun geos-euro sam-ass-da. Geurigo Seokho-do Younghee-ga zun soseol-eul gazang zoahaneun chaek-euro yeogyeooss-da.

Younghee-wa Cheolsu-eui hakk'yo-eseo suhak-eun Gim seonsaengnim-I gareu-chi-sin-da. Gim seonsaengnim-eun maeu eomgyeokha-si-da. Suhak-eun Younghee-ge gazang eoryeoun gwamok-ida. Younghee-eui sowon zung-e hana-ga suhak-eul zalha-neun ges-I-eoss-da. Younghee-neun Seokho-ege doum-eul cheonghaess-da. Geu hu Seokho-neun Younghee-eui zip-euro waseo Younghee-wa hamk'e suhak-eul gongbuhhaess-da. Deudieo gimal siheorn-eseo Younghee-eui sowon-I irueo-zyeoss-da. Geurigo myeochil hu-e Seokho-neun paint-ro zip damzang-eul chilhae-ya-man haess-da. Younghee-neun geu-reul dop-neurago onmom-e paint garu-reul dwizib-eo s' eoss-da. I moseup-eul bogo Seokho-neun yukwehage us-eoss-da.

Myeochil hu-e Younghee-ne zip-cui mun-I zamgyeooss-da. Geuraeseo Younghee-neun Seokho-ne zip-euro dalryeo gass-da. Younghee-neun Seokho-ege doum-eul gidahaess-da. Geureona, Seokho-neun geu saie simbureum t' aemun-e

bak'-e naga iss-eoss-da. It'aemune Younghee-neun eot'eoke mun-eul yeol geos-inga-e daehaeseo gosimha-go iss-eoss-da. Geunyeo-neun zip-e amudo eopt'a-neun sasil-I museo-woss-da. Geut'ase zeogiseo Seokho-ga Younghee-ne zip c'ok-euro daga-wass-da. Gyeolgook mun-eun yeol-ryeoss-da. Younghee-neun Seokho-ga maeu goma-wass-da. Geureona amu mal-do hazi anass-da.

Geureonde, eoneu nal Seokho-neun Younghee-ege isaganda-neun seopseophan sosik-eul zeonhaess-da. Younghee-neun Seokho-ege seonmul-ro zun moza-reul s'eui-woss-da. Geu moza-reul s'eun Seokho-neun azu meos-iss-eoss-da. Daeum nal Seokho-neun truck-e isatzim-eul sil-eoss-da. Geurigo dareun maoul-ro t'eonass-da. Younghee-wa Seokho-neun seoro he-eo zineun geos-I maeu seopseon-haess-da. Geu dongan zazu datugineun hasess-ziman, maebeon god Younghee-neun Seokho-wa hahae-haess-da. Seokho-ga geuriul t'aemyeon Younghee-neun sinaemul wi-e zongibae-reul t'eui-woss-da. T'o Seokho-wa pyeonzi-reul gyohwanhaess-da. Younghee-wa Seokho-neun hangsang seoro-reul zoeun chingu-ro yeogyeoss-da.

## 2.2. Subjects

3 young males in their mid-twenties participated in the recording procedure and they repeated each sentence 3 times. A man with the best performance was finally selected. The decision of best performance was mainly based on the speech rate and clarity. For synthesis purpose, sometimes an analysis of one best performance might be very helpful for the reason that one good sample other than blurred ones can be a good representative of a language.

## 2.3. Recording

3 subjects have read each sentence 3 times. Finally 750 sentences were articulated per subject.

- 1) 150 (15 basic types\*10 manipulation) \* 3 repetition = 450
- 2) 50 separate sentences \* 3 repetition = 150
- 3) 50 continuous sentences \*3 repetition = 150

Recording has been carried out in the sound proof chamber in phonetics/acoustics Lab. in Chungnam National University by use of both AKG D 190E microphone and

SONY TCD-D8 DAT recorder. We also used mixer with two channels each of which was connected to speech input and vocal fold vibration caught by laryngograph separately.

## 2.4. Procedure of signal analysis

A/D convert was carried out by Sun workstation equipped with ESPS/Waves+ (16 kHz sampling rate, 16 bit resolution). All sentences were pre-segmented and labeled to the level of phoneme automatically and finally hand-corrected. F0 was calculated by entire frame\_mean in the vowel portion. In case of energy, we averaged three parts of a syllable.

## III. Subjective Particles and Their Location Within a Sentence

I, first, discriminated three different parts in a sentence, i.e. initial, final (pre-predicate), and medial (etc.). In each material (150 basic:50 separate: 50 continuous) the pattern of F0 contour was investigated with respect to such sentential locations.

F0 and energy were gradually diminished as the particles moved down to the sentential final position, right before the predicate. This can be compatible with the fact that F0 gradually decline from initial to final in a sentence. This also is a language universal fact. In case of English, however, it looks like that focus could be coupled with verb or verb phrase and leads F0 rising. This case shows different aspect from that of English because usual Korean verb phrases should be placed at the sentential final position.

In 150 basic sentences (non-discourse), the inherent topicality of the 'eun/neun' particles seems to show relatively higher F0 (133.3 Hz (n:6, sd:6.98) & 131.6 Hz (n:333, sd:8.99), respectively) as shown in table 1. Concerning 50 continuous discourse sentences, the manifested focusing function of 'ga' can be attached with greater F0 (this case, 'i' could not be measured due to the data deficiency). The energy parameter did not show any significant results.

We could not see significant difference when 50 separate

Table 1. Mean F0 (Hz) of 4 particles at the sentential initial, medial, and final (pre-predicate) position in the 3 different data (150/50/50'). \*: data deficiency

	Eun (150/50/50')	Neun (150/50/50')	i (150/50/50')	ga (150/50/50')
Initial	133/131/133	132/129/130	126/*/*	130/137/136
medial	*/114/122	113/113/109	109/107/104	108/118/117
Pre-predicate	*/108/97	*/**/*	107/103/102	110/113/114

and 50 continuous data were compared. If any, in medial position, subjective 'eun' seems to show quite much difference (114:122). Eventually, we can summarize that

- 1) 'eun/neun' particles might have high F0 at sentential initial position in non-discourse sentence.
- 2) 'i/ga' particles might have high F0 at sentential initial position in discourse sentence.
- 3) 'ga' particle solely seems to show relatively higher F0 in sentential medial in case of both 50 types.

For reference, the following table was attached (table 1).

#### IV. Subjective Particles and Grammatical Relations

Here, it might be needed to know some prosodic relatedness between grammatical relations and words containing the referred subjective particles when a specific grammatical relation precedes or follows a specific subjective particle.

At the sentential medial position, when the words including 'ga, eun, and neun' particles were preceded by adverbials, the acoustic variables of particles specifically tend to be diminished by some ratio in comparison with the mean value. When objectives precede the words, F0 tends to be lowered and duration also shortened, which was statistically not significant. With reference to F0, when adverbials were followed by the particles, the diminishing ratios against the mean of 150 basic sentences were investigated as ga (17%), eun (27%), neun (19%) in case of 50 discourse sentences.

Table 2. Diminishing ratio of F0 against the mean of 150 basic sentences when words with subjective particles were preceded by adverbials.

		Ga	eun	neun
Diminishing ratio (%)	Adverbial+	17%	27%	19%

#### V. Subjective Particles and Prosodic Phrasing

Numerical values of duration have been ordered as  $i < eun < ga < neun$  in every case except of 'neun' in 50 discourse. It seems likely that the prosodic phrasing was more frequently occurred after the eun/neun particles so that the above result could be explained. Following tables show the mean duration of subjective particles, which were discriminated as 150:50:50' types respectively.

From table 3, it might be said that duration can be changed with respect to style variation and especially that it tends to be diminished as proceeding from 150 basic, 50 separate, and finally 50 discourse roughly. However, in case of 'ga' and 'neun', this like assertion doesn't seem to be rightly compatible with.

With respect to prosodic phrasing, a segment can be naturally lengthened before boundary. This also was observed in this experiment but there's some specific phenomenon that prosodic phrasing itself was relatively easily taken place after 'eun' and 'neun' particles. 'eun and neun' have been told to be that they have kind of grammatically contrastive function besides expressing topicality or subjectivity. Potentially added grammatical function would act to make prosodically phrase after the particles (as in table 4).

Table 3. Mean duration (msec) of each subjective particles with respect to style variation, i.e. 150 basic: 50 continuous discourse. Numbers within parentheses indicate each standard deviation.

	i	Ga	eun	Neun
150	88.2 (34.6)	148 (25.2)	135.2 (25)	176 (51.7)
50	72.1 (18)	143.7 (8.5)	133.3 (27)	177.5 (51)
50'	68.6 (25.2)	143.8 (27)	123.7 (19)	112 (56)

Table 4. Mean duration (msed) of each particle, when prosodically phrased (with respect to both acoustically and perceptually) after each one. \* \*Count frequency(%) of prosodic phrasing in entire text (percent)

	l	ga	eun	neun
Mean	118.81	190.82	149	221.37
s.d.	30.89	78.69	28.5	57.92
* * Ratio	21%	14%	23%	33%

## 5.1. Cooperation with Grammatical Relations

It's easily observable that when prosodic phrasing was made before the word containing subjective particles, the grammatical relations preceding the word can be confined to specific 3 or 4 kinds. Generally, absolute words or clause seem to lead prosodic phrasing after themselves because these can be recognized as an independent unit by speaker (table 5).

When prosodically phrased right after the words containing subjective particles, specific grammatical relations following the word tend to be confined to verbal, objectives, and adnouns (table 6).

## 5.2. Interrelationship Between Prosodic Phrase and Syntactic Structure

The prosodic characteristics of inter-word position in

Table 5. Count frequency(%) of specific grammatical relations preceding the words containing subjective particles, when prosodically phrased before the words in entire text. (-) means data deficiency.

	l	ga	eun	neun
Locative +	50%	50%	-	7%
Absolute +	-	22%	-	33%
Clause +	17%	14%	-	60%

Table 6. Count frequency(%) of specific grammatical relations following the words containing subjective particles, when prosodic phrasing take place after the words in entire text. (-) means data deficiency.

	l	ga	eun	neun
+ Adverbial	25%	35%	-	44%
+ Objective	25%	24%	-	8%
+ Adnoun	19%	35%	78%	28%
+ Others	31%	6%	-	20%

which a specific subjective particle was intervened can be captured by the aspect of duration and F0 fluctuation activated in successive 3 syllables in which word or prosodic boundary can be located. The penultimate and boundary syllables are included in the preceding word before boundary and post\_boundary syllable is confined to the first one of following word after prosodic boundary. Because two adjacent words have their own grammatical relations respectively, we can relate them with proper prosodic characteristics just by coupling grammatical relation pair with the acoustic events (durational variation and F0 fluctuation) within successive 3 syllables located in the target two words[8,9].

First, a concrete feature set should be prepared, which can easily describe the prosodic characteristics of successive 3 syllables. Table 7 suggest potential possibility to approach such a goal[8,9].

For example, the first feature (①) can be paraphrased as that ratio for the F0 of penultimate syllable to that of syllable of particle. The implemented prosodic pattern using these features in the successive 3 syllables can be presented as follows (table 8). According to the table 8, there are 4 kinds of F0 fluctuation patterns and 4 kinds of durational variations in the successive 3 syllables. For better comprehension, the 1) pattern related to F0 might be paraphrased like this:

- 1) There are 3 syllables bridging two words.
- 2) Calculation of the F0 ratio on penultimate/particle (boundary) syllable => the result is below 1.
- 3) Calculation of the F0 ratio on particles (boundary)/post particle syllable => the result is below 1, either.
- 4) From these results, we can imagine the continuous rising F0 contour.

Table 7. 4 acoustic features characterizing prosodic boundary unit: ratio  
② means that the ratio acquired from the calculation that F0 value of penultimate syllable divided by that of particle syllable (boundary syllable). ②, ③, and ④ could be explained in the same way as that of ① All ratios will be distributed from 0 to 1.

Contents of acoustic 4 parameters
① penultimate syllable / syllable of particle (F0)
② penultimate syllable / syllable of particle (duration)
③ syllable of particle / post-particle syllable (F0)
④ syllable of particle / post-particle syllable (duration)

Table 8. Implemented prosodic patterns using 4 acoustic features.

Prosodic pattern within 3 syllables	
1)	penulti / parti (Fo:<1) & parti / post_parti (Fo:<1) penulti-parti-post_parti: continuous rise
2)	penulti / parti (Fo:>1) & parti / post_parti (Fo:<1) penulti-parti-post_parti: fall-rise
3)	penulti / parti (Fo:<1) & parti / post_parti (Fo:>1) penulti-parti-post_parti: rise-fall
4)	penulti / parti (Fo:>1) & parti / post_parti (Fo:>1) penulti-parti-post_parti: continuous fall
5)	penulti / parti (dur:<1) & parti / post_parti (dur:<1) penulti-parti-post_parti: short-long-long
6)	penulti / parti (dur:>1) & parti / post_parti (dur:<1) penulti-parti-post_parti: long-short-long
7)	penulti / parti (dur:<1) & parti / post_parti (dur:>1) penulti-parti-post_parti: short-long-short
8)	penulti / parti (dur:>1) & parti / post_parti (dur:>1) penulti-parti-post_parti: long-short-short

Now, I suggest a convenient diagram to catch the brief idea of coupling the presented prosodic patterns in the 3 syllables with syntactic information. Both prosodic aspects that can be depicted as a continuous variation of duration and intonation fluctuation across the 3 syllables and syntactic information can be arranged along with the two dimensional scale (X/Y) simultaneously.

The X-axis refers to the 4 prosodic patterns related to F0, and Y-axis means 4 durational features. It can be, therefore, possible to speak that the potential syntactic and prosodic activity can be grouped together to represent their own prosodic pattern. Table 9 shows the result applied to

Table 9. Distribution of grammatical relation pairs split by major prosodic boundary with respect to durational aspect and F0 fluctuation. The X-axis (5,6,7,8) refers to 4 prosodic patterns related to F0, and Y-axis (1,2,3,4) means 4 durational features.

\* SU: Subject, PR: Predicate, OB: Object, LO: Locative, IN: Instrumental, AV: Adverbial, AD: Adnoun, AB: Absolute, CO: Commitative, SC: Subordinating Clause

	5)	6)	7)				8)
1)	SU * AD		SU * AD AB * AD	SU * AV AB * LO	SU * LO OB * AV	SU * SU SC * LO	
2)	SU * AV		SU * AV LO * OB SC * AV	SU * OB LO * IN	SU * LO LO * SU	IN * OB PR * SU	
3)		CO * AV	SU * AV AV * SU SC * AV	SU * OB IN * LO	AB * AD LO * AV	AB * SU LO * SU	
4)			SU * AD OB * AV	SU * AV SC * AD	AB * SU SC * SU	LO * SU	

the all grammatical relations pair (word to word) including subjectivity in 50 discourse sentences.

## VI. Conclusion

This study investigated some prosodic manifestation of discourse function with respect to various grammatical aspects for the purpose of getting more natural rules for speech synthesis. We have mainly focused to describe the prosodic characteristics of 4 kinds of Korean subjective particles, which were mainly investigated related to sentential location and grammatical relations which can precede or follow the word including subjective particles, and prosodic phrasing.

F0 and energy were gradually diminished as the particles move down to the sentential final position, right before the predicate. Subjective 'ga' particle, which potentially has been regarded as having sort of grammatical focusing function, solely seems to show relatively higher F0 in sentential medial position in discourse. This can be summarized as follows.

- 1) 'eun/neun' particles might have high F0 at sentential initial position in non-discourse sentence.
- 2) 'i/ga' particles might have high F0 at sentential initial position in discourse sentence.
- 3) 'ga' particle solely seems to show relatively higher F0 in sentential medial in case of both 50 types.

At the sentential medial position, when words including 'ga, eun, and neun' particles were preceded by adverbials, the acoustic variables of particles specifically tend to be diminished by some ratio in comparison with the mean value.

The duration of particles can vary with respect to style variation. And especially it tends to diminish as proceeding from 150 basic, 50 separate, and finally 50 discourse roughly. And there's some specific phenomenon that prosodic phrasing itself was relatively easily taken place after 'eun' and 'neun' particles.

Finally, I tried to catch the prosodic characteristics of

inter-word position in which a specific subjective particle was intervened. This can be captured by the aspect of duration and F0 fluctuation activated in successive 3 syllables in which boundary can be located. Tentative approach would be fruitful if some additional research could be followed hereafter.

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### [Profile]

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