Phonetic Approach or Phonological Approach: Syntax-prosody Interface in Seoul Korean

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ABSTRACT

There are two different approaches in studying mapping between syntactic structure and prosody, the 'phonetic approach' and the 'phonological approach'. An experiment to examine which approach is more valid was conducted. In the experiment, syntactically ambiguous Seoul Korean sentences in each of which a noun immediately after an adjective starts with either an H-segment (a segment which triggers the AP-initial H tone) or an L-segment (a segment other than H-segments) were recorded by 3 Seoul Korean speakers. The F0 values in the syllables containing the consonants in question were then measured. The results show that interaction between the segment type and the branching structure is statistically significant, which suggests that it is difficult to use the phonetic approach to generalize the relationship between syntax and prosody. Thus, it is concluded that the phonological approach is more valid.

Keywords : Phonetic Approach, Phonological Approach, Syntax-prosody Interface, Segment Type, Branching Structure

1. Introduction

From recent phonetic and phonological studies, we know that prosody is deeply related to semantic factors such as focus and syntactic factors such as syntactic structure. Of these, this paper deals with syntactic factors.

A disagreement in the previous studies is the way to map syntax to prosody. Here, there are two approaches. One tries to map syntactic structure directly to phonetic features, while the other tries to map syntactic structure to phonological representation, through which phonetic features are reflected indirectly. In this paper, I call the former the 'phonetic approach' and the latter the 'phonological approach'.

In the prosodic study of Seoul Korean as well as other languages, these two approaches have

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been taken. An example of the phonetic approach is Min's (1994) study. He investigated the prosody of syntactically ambiguous sentences. He reported that the left-branching structure has gradual falling without local lowering and rising, while the right-branching structure has lowering of F0 at the syntactic boundary, which follows the rising of F0 to the following syllables. A similar approach can be seen in Choi et al. (1995).

On the other hand, a study of Venditti et al. (1996) is an example of the phonological approach to Korean prosody.[1] They followed Jun's (1993) Intonational Phonological model of Korean prosody, which assumes a hierarchical structure that consists of the Accentual Phrase (AP) and the Intonational Phrase (IP).[2] Based on this model, they reported that the right-branching structure has an IP boundary at the syntactic boundary, while the left-branching structure has neither an IP nor an AP boundary at the same point.

These two approaches are compatible in most cases. If we apply Jun's model to Min's data, the gradual falling in the left-branching structure and the local lowering in the right-branching structure are interpreted as AP dephrasing and the AP-initial L tone, respectively. Thus, these phrasing patterns agree with the reports of Venditti et al. (1996).

If we regard the two approaches merely as descriptive methods, the difference between the two approaches is nothing but the difference in level of abstractness. In this sense, both approaches are descriptively significant. However, when we try to generalize the mapping between syntax and prosody, there is a difference in the model of the mapping that underlies descriptive approaches In other words, there is a difference between the two approaches concerning whether it is necessary to theoretically postulate the phonological prosodic structure between syntax and the phonetic features of prosody or not. The present issue is which approach is more valid in this theoretical sense. We cannot judge the validity of the two approaches from the previous studies introduced above since both approaches properly anticipate the real F0 contour. However, if we examine a case in which the two approaches anticipate different contours, we can judge which is more valid. Before examining such case, the next subsection reviews the influence of obstruents to F0 as background information.

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1) It should be noted that the dialect dealt with by Venditti et al. (1996) is not the Seoul dialect (standard Korean) but the Chonnam dialect.

2) In Jun's (1993) model, AP and IP in Seoul Korean have the following properties. AP is a phrase that consists of one or more phonological words and is characterized by its tonal pattern; LH or LHLH are the typical tonal patterns. On the other hand, IP is a phrase that consists of one or more APs and is marked by boundary tones.

1.1 The influence of obstruents on F0

Korean obstruents are classified into three types based on laryngeal characteristic; plain, aspirated, or tense obstruents. Plain obstruents are voiceless slightly aspirated or voiced sounds; aspirated obstruents are always voiceless; tense obstruents are voiceless unaspirated sounds with glottal tension.

These types of obstruent have different influences on F0. Many researchers have reported that the F0 contour of the vowel following the aspirated or tense obstruents, /s/, or /h/, is higher than that following other segments at the word-initial or phrase-initial position (see Jun 1996 and Nagato 2003 for details). Jun (1996) states that this F0-raising occurs at the AP-initial position.

Although the physical influence of laryngeal features on F0 is observed in various languages, Korean shows remarkable influence. Since this influence seems greater than physical influences, Jun (1996) concluded that high F0 in this case is phonologized as the H tone. This conclusion is reflected in her model of Korean prosody. In her later work (Jun 2000), the tonal pattern of AP is modified from LHLH to THLH, in which T changes to L or H according to the laryngeal feature of the segment.

Hereafter, I call the segments which trigger the AP-initial H tone (i.e. aspirated and tense obstruents, /s/, and /h/) the "H-segments" and the other segments the "L-segments".

1.2 Purpose of the experiment

The purpose of the experiment is to judge which of the two approaches, i.e. the phonetic approach or the phonological approach, is valid. To examine this issue, syntactically ambiguous sentences, such as (1), are used. (1) has syntactic ambiguity in that it has two possible syntactic interpretations. In the left-branching (1a), *elin* (young), modifies only *ttal* (daughter). On the other hand, in the right-branching (1b), *elin* (young), modifies both *ttal* (daughter) and *atul* (son).

(1)	그녀한테는	어린	딸과	아들이	있어요.
	kunye-hanthey-nun	elin	ttal-kwa	atul-i	iss-e.yo
	she-DAT-TOP	young	daughter-and	son-NOM	exist-POL

a: left-branching [NP [NP [AP *elin*] *ttal*] *kwa* [NP *atul*]]
('She has [a young daughter] and [a son].')
b: right-branching [NP [AP *elin*] [N *ttal kwa atul*]]
('She has [a young daughter] and [a young son].')

The following sentence, (2), is similar to (1). However, there is an important difference between the two sentences. (1) has H-segment [t*] immediately after adjective *elin*, while (2) has an L-segment [a] in this position.

(2)	그녀한테는	어린	아들과	딸이	있어요.
	kunye-hanthey-nun	elin	atul-kwa	ttal-i	iss-e.yo
	she-DAT-TOP	young	son-and	daughter-NOM	exist-POL

In these two sentences, the two approaches anticipate different results when we focus on F0 at the point immediately after the adjective. The phonetic approach anticipates that each of the branching structures is characterized by some intrinsic phonetic features, such as F0-lowering in the right-branching structure, irrespective of segment type. Thus, it is expected that there is no interaction between the [branching structure] factor and the [segment type] factor. On the other hand, in the phonological approach, especially that based on Jun's prosodic model, the two branching structures show different patterns at the point in question if the two branching structures show different AP phrasing patterns as reported by Venditti et al. (1996). When there is an AP boundary immediately before the point in question, the H-segments raise F0, but L-segments do not. In contrast, when there is no AP boundary, there is no such effect. Thus, based on this model, interaction between the [branching structure] factor and the [segment type] factor is expected to be statistically significant.

2. Method

2.1 Subjects

The subjects in this experiment are the following 3 native speakers of Seoul Korean.

PYI, born in 1970, male
IJH, born in 1974, female
BIY, born in 1969, female

2.2 Material

This experiment uses syntactically ambiguous sentences. All of the sentences used in this

experiment have the same syntactic ambiguity as those in (1) and (2).[3)]

Table 1: Material. For each sentence, Hangul (Korean characters) and transliterations (the Yale system of Romanization) with glosses are shown. For the words in question, the broad transcriptions of IPA are also shown. The abbreviations used for the glosses are as follows. NOM: nominative case particle, ACC: accusative case particle, DAT: dative case particle, TOP: topic particle, PAST: past tense suffix, POL: polite speech level suffix (so-called *hayyo*-form).

a. H-segments					
H1	그녀한테는	어린	딸과	아들이	있어요.
	kunye-hanthey-nun	Elin	ttal[t*al]-kwa	atul-i	iss-e.yo
	she-DAT-TOP	Young	daughter-and	son-NOM	exist-POL
	a: left-branching ('She has [a young daughter] and [a son].')				
	b: right-branching ('She has [a young daughter] and [a young son].')				
H2	저는	맛있는	초밥과	라면을	먹었어요.
	ce-nun	masissnun	chopap[tɕʰobapˀ]-kwa	lamyen-ul	mek-ess-e.yo
	I-TOP	delicious	Sushi-and	Chinese noodles-ACC	eat-PAST-POL
	a: left-branching ('I ate [delicious sushi] and [Chinese noodles].')				
	b: right-branching ('I ate [delicious sushi] and [delicious Chinese noodles].')				
H3	저는	맛있는	사과와	귤을	먹었어요.
	ce-nun	masissnun	sakwa[sagʷa]-wa	kyul-ul	mek-ess-e.yo
	I-TOP	delicious	apple-and	orange-ACC	eat-PAST-POL
	a: left-branching ('I ate [a delicious apple] and [an orange].')				
	b: right-branching ('I ate [a delicious apple] and [a delicious orange].')				
L-segments					
L1	그녀한테는	어린	아들과	딸이	있어요.
	kunye-hanthey-nun	elin	atul[adɯl]-kwa	ttal-i	iss-e.yo
	she-DAT-TOP	young	son-and	daughter-NOM	exist-POL
	a: left-branching ('She has [a young son] and [a daughter].')				
	b: right-branching ('She has [a young son] and [a young daughter].')				
L2	저는	맛있는	라면과	초밥을	먹었어요.
	ce-nun	masissnun	lamyen[ɾamʲɔn]-kwa	chopap-ul	mek-ess-e.yo
	I-TOP	delicious	Chinese noodles-and	sushi-ACC	eat-PAST-POL
	a: left-branching ('I ate [delicious Chinese noodles] and [sushi].')				
	b: right-branching ('I ate [delicious Chinese noodles] and [delicious sushi].')				
L3	저는	맛있는	귤과	사과를	먹었어요.
	ce-nun	masissnun	kyul[kʲul]-kwa	sakwa-lul	mek-ess-e.yo
	I-TOP	delicious	orange-and	apple-ACC	eat-PAST-POL
	a: left-branching ('I ate [a delicious orange] and [an apple].')				
	b: right-branching ('I ate [a delicious orange] and [a delicious apple].')				

3) It should be noted that these sentences are syntactically different from the syntactically ambiguous sentences in Min (1994) and Venditti et al. (1996), while having the same structure as the sentences in Choi et al. (1995). I use these sentences because they have a simpler syntactic structure than Min's and Venditti et al.'s.

The material sentences in this experiment are classified into two groups by segment type (H-segment vs. L-segment). Each group of sentences consists of three syntactically ambiguous sentences, and each syntactically ambiguous sentence consists of two branching structures (left-branching vs. right-branching). Thus, the material consists of 2 (segment types) × 3 (syntactically ambiguous sentences)×2 (branching structures)=12 sentences. The material is shown in Table 1.

2.3 Recording procedures

The recordings were made on digital audio tape (DAT), using a DAT-corder (Sony TCD D-7) and a dynamic microphone (AKG D112), in a recording booth in the Phonetics Laboratory of the University of Tsukuba.

A set of cards from which to read the material was made as follows. First, each sentence of the material was printed in Hangul (Korean characters) on three cards; thus, a total of 36 cards (12 sentences × 3) were printed. On each card, the syntactic structure is displayed by underlining a part of the sentence.[4] These cards were then randomized. After this, 10 dummy cards were added to the 36 cards, 5 cards at the top and 5 cards at the bottom. The dummy cards were included to obviate the instability of speech intensity. Thus, the full set consisted of 46 cards: 36 cards and 10 dummy cards.

Before the recordings, the subjects were instructed on syntactic ambiguity in the material, were instructed to read the cards as natural speech with specified syntactic interpretation, and were requested to practice reading the cards.

The recordings were made once per subject. Since a set of cards included 3 repetitions, 3 tokens were obtained per sentence.

2.4 Editing and analyzing procedures

The recorded sounds were digitized at 16,000 Hz and were saved as wave files, using WaveStudio (Version 4.50.11, Creative). The files were then analyzed using Praat (Version 4.2.14), the free software developed by P. Boersma and D. Weenink (University of Amsterdam).

In the measurement, the F0 values at the beginning and the middle of the vowel (plus coda)[5] of the syllable in question, i.e. the syllable immediately after the adjective, were measured.

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4) For example, the adjective and the first noun are underlined in the left-branching sentences, and the first and second nouns are underlined in the right-branching sentences.

5) In H1 and L3, the syllables in question contain syllable-final [l].

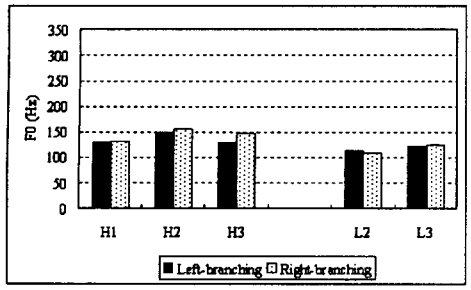
Hereafter, these two points are referred as the 'Beginning' and the 'Middle', respectively. In the segmentation of the vowel (plus coda), the area where vowel formants clearly appear was identified as the vowel (plus coda), referring to the raw waveform and wide-band spectrogram. The F0 values were computed by the standard algorithm in Praat, i.e. the algorithm performing acoustic periodicity detection on the basis of an accurate autocorrelation method, with default settings, which use 0.01 seconds as the measurement interval. In the intervals between computed points, the F0 values were computed by linear interpolation.

The measured data were statistically analyzed by repeated measures ANOVA using 4 factors: segment type, sentence (nested to segment type), subject (block factor), and branching structure.

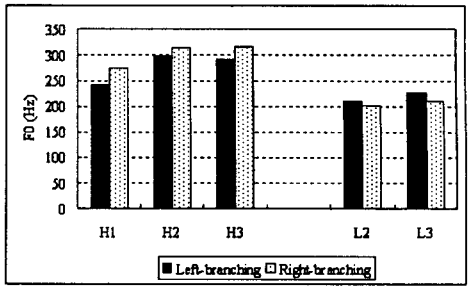
3. Results

3.1 F0 at the Beginning

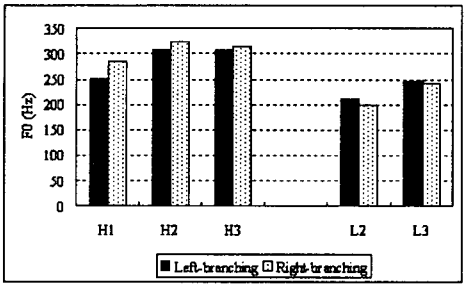
Figure 1 shows the means of the measured F0 values at the Beginning. Since L1, which does not contain the syllable-initial consonant in the syllable in question, often involved unstable F0 caused by glottalization around the Beginning, it was excluded from the figure. Figure 2 shows the averaged F0 values of the two segment types as a function of branching structure. In this figure, H1 was eliminated along with L1 in order to compare H-segments and L-segments in the same number of sentences. As can be seen in Figure 1 and 2, by and large, the left-branching F0 value is lower than the right-branching F0 value in the H-segments, whereas the left-branching F0 value seems to be slightly higher than the right-branching F0 value in the L-segments. The results of ANOVA showed that the interaction between segment type and branching structure is significant (F (1, 94) = 6.41, $p < 0.05$).



a. PYI



b. IJH



c. BIY

Figure 1: Mean F0 values at the Beginning

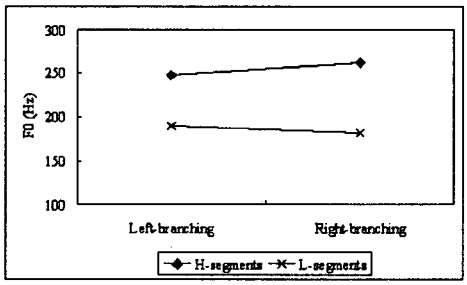


Figure 2: The averaged F0 values of the two segment types as a function of branching structure (at the Beginning)

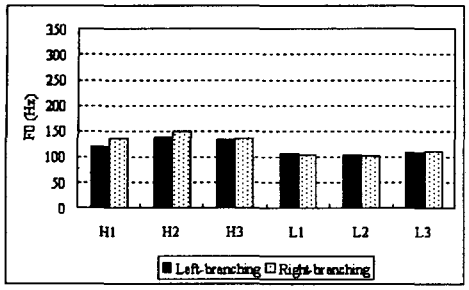
To examine the interaction in detail, two *post hoc* tests were conducted. First, the simple effect test for segment type by branching structure showed that the simple effect of segment type in left-branching structure is significant (F (1, 94) = 93.05, $p < 0.0001$), and that in right-branching structure is also significant (F(1, 94) = 175.0, $p < 0.0001$). These results suggest that F0 after H-segments is higher than that after L-segments both in left-branching and right-branching structures. Second, the simple effect test for branching structure by segment type showed that the simple effect of branching structure in H-segments is significant (F (1,

94) = 5.52, $p < 0.05$), but that in L-segments is not significant (F (1, 94) = 1.51, p = 0.2234). These results suggest that F0 in left-branching structure is lower than that in right-branching structure when it follows H-segments, but the F0 values in these two branching structures are not different when it follows L-segments.

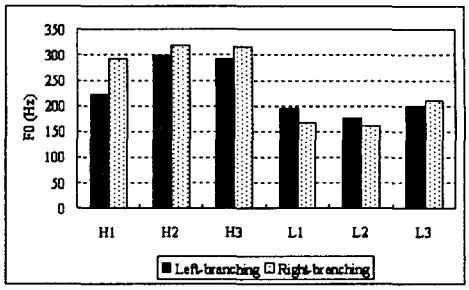
3.2 F0 at the Middle

Figure 3 shows the means of the measured F0 values at the Middle. Figure 4 shows the averaged F0 values of the two segment types as a function of branching structure. As can be seen in these figures, by and large, the left-branching F0 value is lower than the right-branching F0 value in the H-segments, whereas the F0 values in two branching structure are not different in the L-segments. The results of ANOVA showed that the interaction between segment type and branching structure is significant (F (1, 94) = 9.51, $p < 0.01$).

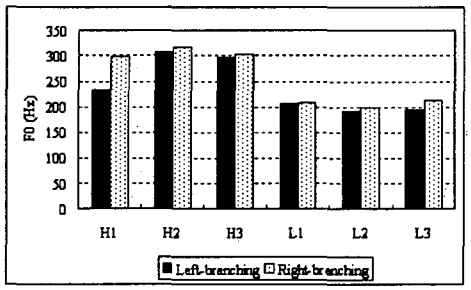
To examine the interaction in detail, two *post hoc* tests were conducted. First, the simple effect test for segment type by branching structure showed that the simple effect of segment type in left-branching structure is significant (F (1, 94) = 110.7, $p < 0.0001$), and that in right-branching structure is also significant (F(1, 94) = 221.4, $p < 0.0001$). These results suggest that F0 after H-segments is higher than that after L-segments both in left-branching and right-branching structures. Second, the simple effect test for branching structure by segment type showed that the simple effect of branching structure in H-segments is significant (F (1, 94) = 18.53, $p < 0.0001$), but that in L-segments is not significant (F(1, 94) = 0.003, p = 0.9547). These results suggest that F0 in left-branching structure is lower than that in right-branching structure when it follows H-segments, but the F0 values in these two branching structures are not different when it follows L-segments.



a. PYI



b. IJH



c. BIY

Figure 3: Mean F0 values at the Middle

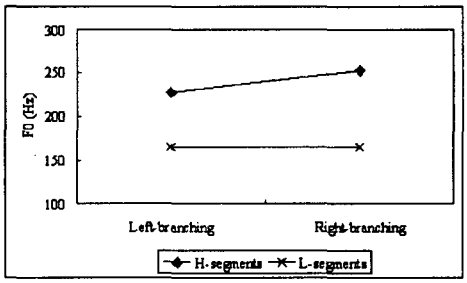


Figure 4: The averaged F0 values of the two segment types as a function of branching structure (at the Middle)

4. Discussion

4.1 Phonetic approach or phonological approach

As stated in Section 1, this experiment examined the validity of two approaches. The results showed that the interaction between segment type and branching structure was statistically

significant both in the Beginning and the Middle. The results of the *post hoc* tests revealed that, while the F0 values in the left- and right-branching structures were not different in the L-segments, those in the H-segments showed the clear tendency; i.e. the left-branching structures were lower than the right-branching structures. Interestingly, this tendency in the H-segments is opposite to the tendency found in the previous studies (see Section 1). These findings question the assumption of the phonetic approach that a phonetic boundary is characterized by some intrinsic phonetic features, suggesting the validity of the phonological approach.

4.2 Remaining issue

Even though the purpose of this experiment has been achieved so far, there is a point to be noted. If the AP phrasings of the two branching structures are those reported in Venditti et al. (1996), i.e. AP dephrasing occurs in left-branching while it does not occur in right-branching, and if the tonal pattern of AP with an AP-initial H-segment is HHLH as stated by Jun (1993), it is expected that L tones appear at the measured point in the left-branching structures while H tones appear in the right-branching structures. Thus, the expected difference in F0 between the two structures is quite large. However, the actual difference is not so large, and tones that appeared in the left-branching structures seem to be H tones rather than L tones. We can also see this in the representative F0 contours of sentences with H-segments (Figure 5). We now further discuss the disagreement between the expected and the actual results.

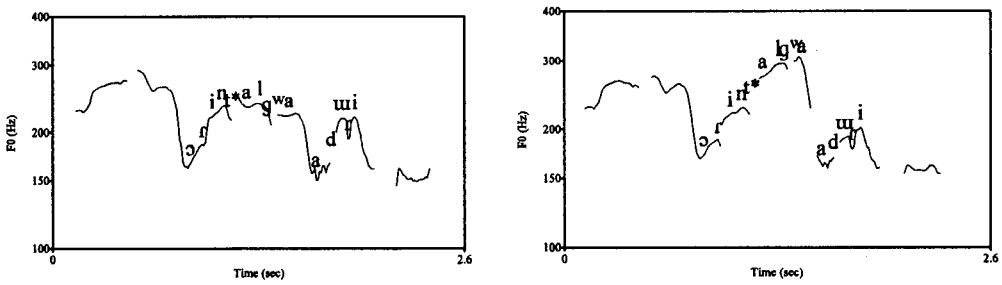


Figure 5: The F0 contours of sentences with H-segments (subject: IJH, sentence: H1). Left: left-branching structure, right: right-branching structure.

There are two possible interpretations. The first is that, in left-branching structures, AP dephrasing occurs and, at the same time, the undershoot effect of the AP-medial L tone occurs.

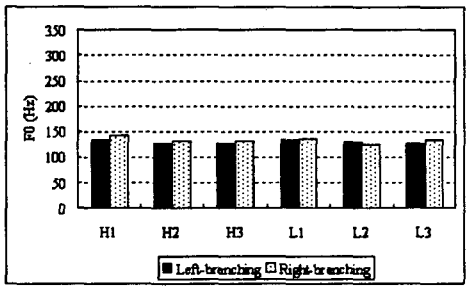
The undershoot effect of the L tone has been reported in previous studies (Jun 1993: 46, Mimatsu and Utsugi 2002: 68). Interestingly, this effect is only seen in H-segments. It is an interesting novel discovery if the H-segments in the AP-medial position trigger the undershoot effect of the AP-medial L tone.

The second interpretation is that both the two structures mentioned show no AP dephrasing between the adjective and the first noun. In this view, high pitch after the H-segment both in the left- and right-branching structures is explained as the AP-initial H tone triggered by the preceding H-segment. In addition, the fact that the F0 values in the L-segments were not significantly different between two branching structures can also be explained in this view; namely, both the structures involved the AP-initial L tone in the L-segments. I adopt this no-AP-dephrasing view for the following two reasons.

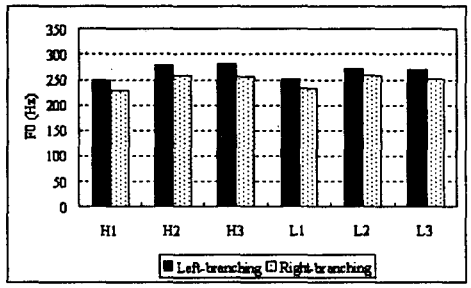
First, the pitch pattern of the adjective does not agree with the expectation. If the left-branching structure showed dephrasing and the right-branching structure did not, it is expected that the final rise of the adjective in the left-branching structure would be lower than that in the right-branching structure, since it is known that an AP-medial H is lower than an AP-final H in general(Jun 1993). However, the actual pattern differs from this expectation, as shown below.

I made an additional measurement to the peak F0 in the final syllable of the adjective[6]. Figure 6 illustrates the peak F0 in the left- and right-branching structures. As can be seen, IJH's data are contrary to the dephrasing-view's expectation that the left-branching structure is lower than the right-branching structure. The results of the repeated measures ANOVA (factors: segment type, sentence (nested to segment type), subject (block factor), and branching structure) showed that the main effect of the branching structure is not significant (F = 0.72, p = 0.3991). This is contradictory to the expectation of the dephrasing-view to which I am opposing.

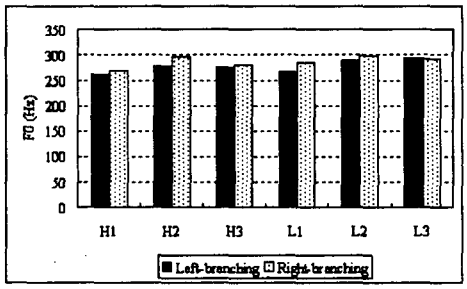
6) Except for the points to be measured, the procedures in this measurement are the same as those described in the section 2.4.



a. PYI



b. IJH



c. BIY

Figure 6: Averaged peak F0 values in the final syllable of the adjective in the left- and right-branching structures

The second reason to adopt the no-AP-dephrasing view is that another study of mine (Utsugi 2004) implies the frequent occurrence of the no-AP-dephrasing pattern in the left-branching structure. In that study, I used longer modified nouns with syntactically identical structures to the present study and found that the first noun in the left-branching structure had a suppressed, but not deleted, AP-medial H tone, suggesting no AP dephrasing.[7)]

Thus, I take the view that no AP dephrasing occurs, both in the left- and right-branching structures. In taking this view, however, two questions arise. The first question is why it disagrees

7) The results of the latest study conducted by Jun & Kim (2004) also imply the frequent occurrence of the no-AP-dephrasing pattern. They conducted production and perception experiments using syntactically ambiguous sentences. The production experiment showed that Korean speakers prefer the pattern of no-AP-dephrasing ('neutral boundary' in their term) at a high rate. In the perception experiment, subjects tended to interpret the ambiguous sentences as right-branching ('High attachment' in their term), but its rate was not so high (60%). Even though their experiments were not designed to identify the correlative to some syntactic structures, it seems that the results imply that the Korean language prefers the no-AP-dephrasing pattern irrespective of syntactic structure.

with the results of the AP phrasing of Venditti et al. (1996). This disagreement may result from differences in material and/or differences in dialect (Seoul vs. Chonnam). What is more, if syntactic structure imposes just a negative constraint on prosodic structure as proposed by Jun (1993: 213), it can be expected that the results of Venditti et al. and our results disagree.

The second question is why there is a difference in F0 between the two branching structures even though it is not large. If the AP phrasings of the two structures are equal, the expected tone should also be equal. There may be unknown effects on these sentences. Further investigation is necessary for the elucidation of this problem.

We have so far discussed the mismatch between expectations and actual results. The above discussion concerns issues on the syntax-phonology interface and the phonology- phonetics interface, which is to be examined further. However, it is clear that the phonetic approach cannot account for the interaction identified in the experiment.

5. Conclusion

I have so far reported an experiment to examine the validity of the two approaches to syntax-prosody interface, i.e. the phonetic approach and the phonological approach. The results of our experiment indicate that the phonological approach is more valid for syntax-prosody interface.

This paper focuses on the basic framework of mapping in the syntax-prosody interface. It should be noted that the results do not prove the claims of previous studies on the concrete pattern of mapping in the syntax-phonology interface and phonology-phonetics interface. In addition, even though this experiment suggests the necessity of certain phonological prosodic models, it does not suggest the validity of the specific models proposed in previous studies, such as Jun's (1993) model. The future direction of this study should examine these claims and models.

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