The intermediate phrase in Korean: Evidence from sentence processing

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Abstract

This contribution reports default phrasing and relative clause (RC) attachment experiments on Japanese and Korean, testing the Implicit Prosody Hypothesis (IPH) proposed by Fodor and colleagues (e.g., Fodor 1998, 2002; Quinn, Abdelghany, and Fodor 2000), and revisits the intonation model of Seoul Korean (Jun 1993, 1998, 2000). According to the IPH, a default prosodic contour projected onto a sentence favors, other things being equal, the syntactic analysis associated with the default prosody for that construction. This hypothesis predicts that default phrasing in languages such as Japanese and Korean, which have a high attachment preference, would result in a larger prosodic break after the RC than after the NP1 (in the structure RC NP1 NP2). The results of Japanese default phrasing supported the prediction, but the results from Korean did not. Reexamination of the Korean phrasing data revealed that some Accentual Phrase (AP) boundaries have a bigger juncture than the default AP juncture (but still smaller than the Intonation Phrase (IP) level) when the AP final tone preceding the juncture is higher than that of the preceding AP or when the AP following the juncture has a higher pitch range than the preceding AP. It was proposed that this level of juncture is an Intermediate Phrase boundary, larger than an AP and smaller than an IP. The Korean default phrasing reanalyzed under this revised model supported the prediction made by the IPH.

1. Introduction

The garden path effect in sentence processing can be observed in reading temporarily ambiguous sentences as in (1). At first reading, the word, *raced,* in (1a) tends to be parsed as the predicate of the main subject, *the horse*; thus, when a parser confronts a second predicate, *fell*, the parser realizes that the first interpretation is not right, leading to a reanalysis. In (1b), the word, *the house*, tends to be parsed as the object of the main verb, *leaves*; thus, when confront-

ing the second predicate, *is*, the parser realizes that the object should be reanalyzed as a subject of a subordinate clause.

(1) a. *The horse raced past the barn fell.* (Bever 1970)
b. *When Roger leaves the house is dark.* (Kjelgaard and Speer 1999)

This has been taken as evidence that there is a mechanism in sentence processing which guides a parser. Psycholinguists have hypothesized that there exists a human sentence processing mechanism which is innate and universal (e.g., minimal attachment, late closure, or right association by Kimball 1973; Fodor, Bever and Garrett 1974; Frazier and Fodor 1978; Frazier 1978; Frazier and Rayner 1988; Fodor 1998). One of the main ideas of this hypothesis is that when possible, attach incoming material into the clause or phrase currently being parsed, i.e., attach low. This explains why a parser tends to interpret the word *raced* in (1) as the predicate of the main clause and the word *the house* as the object of the main clause. Starting a new clause or phrase, thus attaching high, is costly in parsing. High vs. low attachment can be illustrated in the example sentence in (2). In this sentence, the attachment of the relative clause (RC), *who was on the balcony*, is ambiguous. It can modify the embedded noun *the actress*, i.e., attach low, or the head noun, *the servant*, i.e., attach high.

(2) *Someone shot the servant of the actress who was on the balcony*
(Cuetos and Mitchell 1988)

When the head noun of an RC is a complex noun phrase (NP) as in (2), the RC tends to attach low in English, (e.g., Carreiras and Clifton 1993, 1999; Fernández 2003), but this attachment preference has turned out to be language-specific. High attachment is preferred by speakers of Dutch (Brysbaert and Mitchell 1996), French (Zagar, Pynte, and Rativeau 1997), German (Hemforth, Konieczny, Scheepers, and Strube 1998), Japanese (Kamide and Mitchell 1997), and Spanish (Cuetos and Mitchell 1988), while low attachment is preferred by speakers of Arabic (Quinn, Abdelghany, and Fodor 2000), English (Frazier and Clifton 1996), and Norwegian, Romanian, and Swedish (Ehrlich, Fernández, Fodor, Stenshoel, and Vinereanu 1999). (See Fernández 2003, for more detail). This apparent cross-linguistic difference has challenged the universalist view of sentence processing.

Psycholinguists have attempted to explain the cross-linguistic difference, and one of the proposals is the Implicit Prosody Hypothesis (IPH) proposed by Fodor and her colleagues (Bader 1998; Quinn et al. 2000; Fodor 1998, 2002).

The IPH states that in silent reading a default prosodic contour projected onto the sentence favors, other things being equal, the syntactic analysis associated with the default prosody for the construction. Note that the studies on attachment preference were based on 'silent reading', i.e., no overt prosody, thus 'implicit prosody'. The role of overt prosody in sentence processing has been well-known. Auditory sentence input with overt prosody prevents the garden path and helps the resolution of syntactic ambiguity. Schafer (1997) and Kjelgaard and Speer (1999) found slower processing time when an Intonation Phrase (IP) boundary of a sentence does not match its syntactic phrase boundary. For example, the sentence in (1b) is processed faster when an IP boundary is located after *leaves* than after *the house*.

Since languages differ in their prosody, attachment preferences would differ across languages. This hypothesis is supported by the effect of prosody on attachment resolution: short RCs tend to attach low and long RCs tend to attach high (see Fodor 1998 and the references cited there). Maynell (1999) and Lovrić, Bardley, and Fodor (2000, 2001) found that speakers interpret a prosodic break before an RC (in a sequence of NP1 NP2 RC) as a marker of a stronger syntactic boundary, which prompts high attachment (i.e., RC modifying NP1, i.e., *the servant* in (2)). This suggests that speakers of a language with a high attachment preference would tend to produce a prosodic boundary between the RC and the adjacent noun in the default phrasing of a sentence, but not between the two nouns (i.e., NP1 and NP2).

In this article, I will report the default phrasing and RC attachment experiments on Japanese (Jun and Koike 2003) and Korean (Jun and Kim 2004), testing the Implicit Prosody Hypothesis (IPH), and revisit the intonation model of Korean (Jun 1993, 1998, 2000). Japanese is chosen because the syntax and RC attachment preference are the same as in Korean; both have the same word order and prefer high attachment. Another reason to compare Korean with Japanese is that both languages have a similar prosodic structure, described in the same theoretical framework, Intonational Phonology (Pierrehumbert and Beckman 1988; Venditti 1995, 2005 for Japanese, and Jun 1993, 2000 for Korean). Thus, it is expected that the relation between attachment preference and prosodic phrasing would be similar between these two languages.

The production and processing of RC attachment data of Korean suggest that Korean may have an Intermediate Phrase, a prosodic unit higher than an Accentual Phrase and smaller than an Intonation Phrase. Assuming an Intermediate Phrase in Korean explains the correlation between the processing (i.e., attachment preference) and production (i.e., prosodic phrasing) results in Korean as well as the similarity between Japanese and Korean attachment data.

The organization of the article is as follows. Sections 2 and 3 describe the default phrasing and the attachment preference of an RC in Japanese and Korean, respectively. Section 4 revisits the intonation model of Seoul Korean and presents the reanalysis of the production data. Section 5 discusses the results and suggests future research.

2. Default phrasing and RC attachment in Japanese

Jun and Koike (2003) investigated if Japanese speakers, who are known to prefer high attachment of an RC (Kamide and Mitchell 1997), would produce a larger prosodic break after the RC than after NP1 in their default phrasing, i.e., prosodic grouping: RC // NP1 NP2. In Japanese, the word order is the opposite of that in English and the NP1 is followed by the genitive particle *-no*, corresponding to the 'NP1's NP2' structure in English. That is, in the RC NP1 NP2 structure, NP1 is the embedded noun, *the actress* in (2), with a genitive marker, and NP2 is the head noun, *the servant* in (2): *who was on the balcony – the actress's – the servant.*

2.1. Method

Thirty speakers of Tokyo Japanese were divided in two groups. Half of them were asked to read each sentence after skimming briefly (Skim Group), while the other half were asked to read the sentences without skimming first (No-skim Group). The purpose of this grouping was to investigate if there is any effect of familiarity with the sentence on the prosodic phrasing. It is hypothesized that, by skimming a sentence before reading, subjects may notice the ambiguity of the sentence meaning, and depending on their first interpretation, they may try to disambiguate it by changing the prosodic phrasing.

Speakers read a randomized set of 48 target sentences and 36 filler sentences. The target sentences varied with regard to the location of the complex noun phrase "RC NP1 NP2" (LOCATION: sentence-initial vs.-medial[1]), and the length and the accentedness of RC, NP1, and NP2. There were four types of length combinations and six types of accent combinations as shown in (3). A short RC, shorter than 6 moras, consists of a single word, i.e., a Verb as shown in (4), while a long RC, longer than 10 moras, consists of multiple words.

(3) a. LENGTH (default/long/short)
ddd – default RC (7–8 mora) + default NP1 (4–5 mora) + default NP2
ldd – long RC (> 10 mora) + default NP1 (4–5 mora) + default NP2
sls – short RC (< 6 mora) + long NP1 (> 6 mora) + short NP2
ssd – short RC (< 6 mora) + short NP1 (1–2 mora) + default NP2
b. ACCENT (Accented/Unaccented RC, NP1, or NP2)
A+A+A, U+A+A, A+U+A, A+A+U, A+U+U, U+U+A

An example of 'sentence-medial' LOCATION, 'sls' LENGTH, and 'U+A+A' ACCENT (i.e., short unaccented RC, long, accented NP1, and short, accented NP2) is shown in (4). The target structure is underlined.

(4) *Gakusei'tachi wa.* *nakunatta* *daigakukyo'oju no* *tsu'ma ni*
The student-TOP who died college professor-GEN wife-with
ichido mo a'tta koto' ga na'katta.
never to have met-negative-past
'The student had never met the wife of the college professor who died'

Sentences were digitized, and the intonation/phrasing was transcribed using Japanese ToBI conventions (Venditti 1995, 2005).

The same subjects participated in the processing experiment (i.e., off-line questionnaire test) three weeks after the production experiment. The questionnaire consisted of the 48 target sentences used in the production experiment randomized with 57 filler sentences. A comprehension question was added below each sentence (e.g., 'who died?' was written below the sentence in (4) above). Two choices, NP1 and NP2, were given as the possible answer. Their answers indicate high or low attachment of the RC. Subjects were told to choose the answer without thinking too much about the question and were not allowed to change their answer. This experiment was added not only to confirm the previous findings but also to examine the effect of prosodic factors (location of RC+NP1+NP2 and the length and the accentedness of RC, NP1, and NP2) on the processing of RC attachment.

2.2. Results

Results of the processing experiment showed that the majority of Japanese speakers (66%) preferred High attachment, confirming previous studies (e.g. Kamide and Mitchell, 1997). Logistic Regression analyses show that there is no significant main effect of GROUP[2] and LOCATION, but significant effect of LENGTH (Skim group only) and ACCENT (both groups). Sentences with a long RC ('ldd') were interpreted as high attachment significantly more often than those with a default length RC. The RC was interpreted as high attachment more often for 'AUA' (for no-skim group) and 'AUU' (for both groups)

compared to that for 'AAA'. That is, the RC was often interpreted to modify NP2 when followed by an *unaccented* NP1.

Results of the production experiment supported the prediction, i.e., the default phrasing of a language with a high attachment preference has a larger prosodic break between the RC and the adjacent NP than the prosodic break between the two nouns, i.e., RC//NP1 NP2. According to the Japanese ToBI (J_ToBI) model (Venditti 1995, 2005), there are two prosodic units: an Intonation Phrase (IP) and a smaller phrase called an Accentual Phrase (AP). The IP in J_ToBI is a combination of the Utterance and Intermediate Phrase in Beckman and Pierrehumbert (B&P) 1986 and Pierrehumbert and Beckman's (P&B) 1988 Model. Therefore, the end of an IP in J_ToBI is marked by the boundary tone and phrase final lengthening (same as the Utterance in B&P and P&B) as well as by the pitch reset/downstep (same as the Intermediate Phrase in B&P and P&B). That is, an IP is the domain of downstep for a sequence of accented APs, and is also marked by the absence of AP-initial lowering for a sequence of unaccented APs. The break index, representing the degree of juncture between any two consecutive words, is 3 after an IP, 2 after an AP, and 1 after an AP-medial word. This means the strength of a prosodic boundary is IP>AP>Word. However, as shown in Carlson, Clifton, and Frazier (2001), the strength of a prosodic boundary is not absolute, but relative. That is, subjects perceive a big juncture at a certain point only when the preceding juncture is smaller than the current one. If both the RC and the NP1 are marked by the same type of prosodic boundary, subjects would not perceive any grouping among the components.

Since the IPH predicts a bigger boundary after the RC than that after the NP1 for high attachment languages, '$(RC)_{AP}(NP1\ NP2)_{AP}$' is considered to represent the same grouping as '$(RC)_{IP}((NP1)_{AP}(NP2)_{AP})_{IP}$'. That is, both groupings show a larger break after RC than after NP1 in this structure. Following this criterion, Japanese target sentences showed three types of prosodic grouping as shown in (5).

(5) a. *early* boundary: (RC) // (NP1 NP2), a larger boundary after RC than after NP1
e.g., $(RC)_{AP}(NP1\ NP2)_{AP}$ or $(RC)_{IP}(NP1\ NP2)_{IP}$

b. *late* boundary: (RC NP1) // (NP2), a larger boundary after NP1 than after RC
e.g., $(RC\ NP1)_{AP}(NP2)_{AP}$ or $((RC\ NP1)_{IP}(NP2)_{IP}$

c. *neutral* boundary: (RC) // (NP1) // (NP2), same level of boundary before/after NP1
e.g., $(RC)_{AP}(NP1)_{AP}(NP2)_{AP}$ or $(RC)_{IP}(NP1)_{IP}(NP2)_{IP}$ or $(RC)_{W}(NP1)_{W}(NP2)_{W}$

Results show that Japanese speakers produced an 'early' boundary two thirds of the time (66~67%), a 'late' boundary only 7~10% of the time, and a 'neutral' boundary for the rest (22~26%). Logistic Regression analyses showed that there is a significant difference between Groups in production data (χ^2=6.718, p=.0348). Skim Group produced more cases of 'neutral' boundary and fewer 'late' boundary cases than No-skim Group. Furthermore, there is a significant difference in the LOCATION for Skim Group (χ^2=8.653, p=.0132). Speakers produced more 'late' boundaries in sentence-medial than sentence-initial positions. Speakers in both groups showed the effect of LENGTH (Skim Gr.: χ^2=35.434, p<.0001; No-skim Gr.: χ^2=16.629. p=.0107). Compared to the default length ('ddd'), speakers produced more 'early' boundaries when the RC was long ('ldd'), and fewer 'late' boundaries when RC was short ('ssd' or 'sls'). Finally, speakers in both groups showed the effect of ACCENT (Skim Gr.: χ^2=114.089, p<.0001; No-skim Gr.: χ^2=149.575. p<.0001). Compared to the 'AAA' type accent, they produced more 'early' boundaries when the NP1 was unaccented ('AUU' or 'AUA') and more 'late' boundaries when the RC was unaccented ('UAA'). The number of 'early' boundary tokens is, from the highest to the lowest: AUU (22.1%), AUA (20.8%), AAU (16.5%), UUA (16.4%), AAA (15.49%), and UAA (8.5%); data based on 967 tokens. This confirms the previous finding that an unaccented word tends to form one prosodic unit together with the following word (e.g. Kubozono 1993; Kondo and Mazuka 1996; Venditti and van Santen 2000; Hirose 2003).

The patterns found in the production and processing experiment held the same for individual speakers. Most speakers produced 'early' boundaries 60–80% of the time, 'late' boundaries 4–8% of the time, and 'neutral' boundaries the rest of the time. For processing, 26 out of 30 speakers preferred high attachment. Among those 4 speakers who preferred low attachment, only 1 speaker produced 'early' boundaries less than 60% of the time. This suggests that even though default phrasing is not fixed for each sentence and is not the same for every speaker (but influenced by phrase length and accent), there seems to be a common type of default phrasing for a certain structure across speakers. And this common default phrasing is what is predicted from the attachment data.

In sum, the experiment showed that there is a correlation between prosodic phrasing and attachment preference as predicted by Fodor's IPH. Japanese speakers produced 'early' phrasing 65% of the time and preferred 'high' attachment 66% of the time. It also showed that both the default phrasing and attachment resolution were influenced by prosody. Speakers produced more 'early' phrasing and preferred more 'high' attachment when the RC was long and when the NP1 was unaccented.

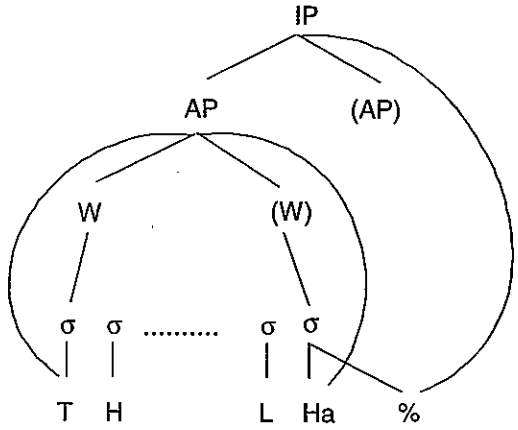
3. Default phrasing and RC attachment in Korean

Jun and Kim (2004) performed a similar experiment on Korean data to investigate the default phrasing of the 'RC NP1 NP2' structure in Korean and the attachment preference of Korean speakers. This was the first systematic study investigating the attachment preference of Korean. Though Korean and Japanese are known to have similar morphosyntactic properties, it is not necessarily predictable that the two languages would have the same attachment preference. As mentioned in the Introduction, the prosodic structure at a phrasal level is similar between the two languages, but the lexical prosody is quite different. Japanese (Tokyo) is a lexical pitch accent language, having accented and unaccented words specified in the lexicon, while Korean (Seoul) does not have any prosodic specification at the lexical level.

3.1. Method

As in the Japanese data, thirty speakers of Seoul Korean participated in both production and processing experiments. Again, the speakers were divided into two groups (GROUP: Skim Group and No-skim Group), and read a randomized set of 32 target sentences and 24 filler sentences.[3] The target sentences had the RC NP1 NP2 structure and varied with regard to the length of the RC (LENGTH: default length RC of 6–7 syllables, long RC of 9–10 syllables, and short RC of 3–4 syllables) while maintaining the default length of the NP1 and NP2, 3–4 syllables.[4] In addition, for the default length of the RC, the location of the RC NP1 NP2 structure varied (LOCATION: sentence-initial vs. sentence-medial).[5] Sentences were digitized, and intonation/phrasing was analyzed using Korean ToBI conventions (Jun 2000) which were based on Jun's (1993, 1998) model of Korean intonational phonology, shown in (6).

(6) Prosodic Structure of (Seoul) Korean (Jun 1993, 1998)



IP = Intonation Phrase, marked by a boundary tone %.
AP = Accentual Phrase, marked by THLHa tone pattern.
T = H if AP initial segment is aspirated or tense C, /h/, or /s/; L, otherwise.
W = phonological word; σ = syllable.

As shown in (6), the largest prosodic unit in Korean is an Intonation Phrase (IP). It can have one or more Accentual Phrases (AP) and is marked by phrase final lengthening and a boundary tone (L%, H%, LH%, HL%, LHL%, etc.). An AP can have one or more Words (W) and is marked by a tonal pattern, THLHa, with the first two tones realized on the AP-initial two syllables and the last two tones realized on the AP-final two syllables. The AP-final high tone (Ha) marks the end of an AP, but when an AP-final syllable is also an IP-final syllable (i.e., IP-final AP), the Ha tone is overridden by an IP final boundary tone. The AP-initial tone, i.e., 'T' in (6), can be H or L depending on the laryngeal property of the AP initial segment. It is H if the segment is aspirated and tense consonants, /s/, or /h/, but is L otherwise. When an AP is longer than three syllables, both initial and final rising tones are realized, but when it is shorter than four syllables, the two medial tones, either one or both of them, are often not realized, resulting in LLHa, LHHa, LHa (or HLHa, HHa when H-initial). Finally, unlike an IP, an AP is not marked by phrase final lengthening. That is, a phrase boundary ending in an H tone is H% (not Ha) only when the phrase-final syllable is lengthened.

Unlike the procedure employed in the Japanese experiment, the processing experiment (off-line questionnaire test) was performed right after the produc-

tion experiment by the same subjects. This is because a pilot study showed that delaying the processing experiment did not affect the performance. The questionnaire included a randomized set of 32 target sentences and 32 filler sentences, and the subjects were asked to choose either NP1 or NP2 as the answer to a question triggering either high or low attachment of the RC. The subjects were given the same instruction as in the Japanese experiment.

3.2. Results

The results of the processing experiment showed that, similar to Japanese speakers, 60% of Korean speakers preferred High attachment. There was a significant main effect of GROUP: Skim group chose high attachment more often than No-skim group ($\chi^2(1)=5.017$, $p=.0251$). Repeated ANOVA also shows that there was a significant main effect of LENGTH for both by subject ($F(2, 56)=16.427$, $p<.001$) and by item ($F(2, 21)=4.538$, $p=.023$) but a significant effect of LOCATION only by subject ($F(1, 28)=16.028$, $p<.001$). Short RCs were interpreted as high attachment less often than default or long RCs (see Fig. 1), and a sentence-initial RC was interpreted as high attachment more often than a sentence-medial RC (see Table 1).

The results of the production experiment showed that the target structure in Korean is phrased in three ways as in Japanese: 'early' boundary (RC // NP1 NP2), 'late' boundary (RC NP1 // NP1), and 'neutral' boundary (RC // NP1 // NP2). Since the prosodic grouping is relative, as mentioned in section 2.2, the phrasing of the target phrase was defined as 'early' boundary if it was either $(RC)_{IP}(NP1\ NP2)_{IP}$ or $(RC)_{AP}(NP1\ NP2)_{AP}$, and as 'late' boundary if it was either $(RC\ NP1)_{IP}(NP2)_{IP}$ or $(RC\ NP1)_{AP}(NP2)_{AP}$. A 'neutral' boundary was defined when the phrasing was $(RC)_{IP}(NP1)_{IP}(NP2)_{IP}$, $(RC)_{AP}(NP1)_{AP}(NP2)_{AP}$, or $(RC\ NP1\ NP2)_{AP}$.

The frequency of each boundary type for the LENGTH/LOCATION category is shown in Table 2. Data show that, unlike Japanese speakers, the majority of Korean speakers (86.25%, the average of the two Groups) produced a 'neutral' boundary as their default phrasing. The most common neutral boundary was '$(RC)_{AP}(NP1)_{AP}(NP2)_{AP}$'. Surprisingly, there was no main effect of GROUP, LENGTH, and LOCATION. That is, the pattern of default phrasing was not influenced by prosodic factors. Speakers produced similar default phrasing of the target structure whether they had time to skim or not, whether the RC was long or not, and whether the target phrase was sentence-initial or not. This pattern was the same across all speakers.

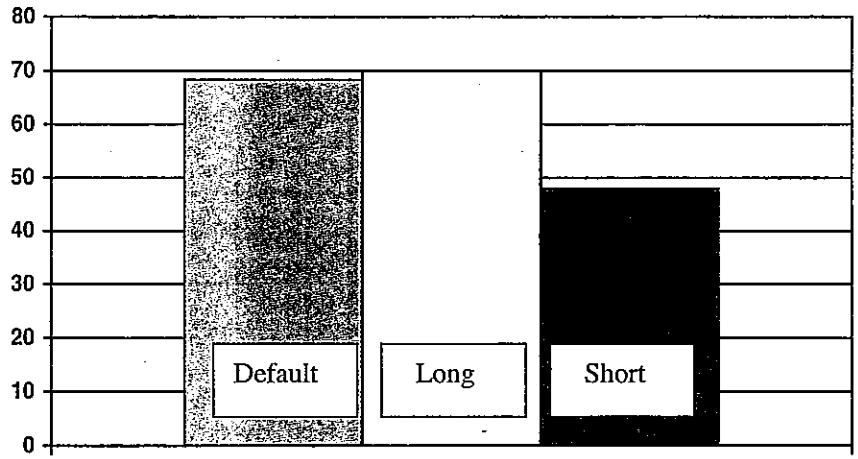


Figure 1. Percentage of high attachment in Korean depending on the length of RC, default, long, and short.

Table 1. Percentage of high attachment in Korean depending on the location of the 'RC NP1 NP2' structure in each subject Group.

Location\Group	Skim	No-skim
Sentence-initial	70.83%	65.83%
Sentence-medial	58.33%	49.16%

It seems then that, unlike the Japanese data, the Korean phrasing data do not support the prediction of Fodor's Implicit Prosody Hypothesis. In other words, processing data show that Koreans prefer high attachment, but phrasing data show that, in most cases, the prosodic break after an RC is the same as that after NP1, i.e., 'early' boundary was not the common default phrasing.

However, the result that the default phrasing is not influenced by prosodic factors seems unnatural and differs from previous findings. Studies (e.g. Jun 1993, 2003a, b, 2005) have shown that, like other languages, Korean prosodic phrasing (Accentual Phrasing or Intonational Phrasing) is indeed influenced by the length of the phrase. A sequence of two words, if semantically related, tends to form one AP when it has 5 syllables or less. It forms two separate APs when longer than 5 syllables (Jun 2003a, b). A short sentence often forms one IP, but when a sentence has more than 15 syllables (about 4 or 5 words), it tends to be phrased in two IPs (Kim et al. 1997; Jun 2005).

Table 2. Frequency of default phrasing types of the target phrase for the LENGTH/LOCATION categories in each Group (480 tokens each). 'Def-Mid' is the condition where a default length RC occurs in sentence-medial position. (Percentages were given in parentheses for only 'Sum' data)

Group	Length/Loc	Early	Late	Neutral
Nskim	Default	9	4	107
	Long	17	2	101
	Short	10	2	108
	Def-Mid	10	3	107
	Sum	46 (9.6%)	11 (2.3%)	423 (88.1%)
Yskim	Default	18	0	102
	Long	19	4	97
	Short	11	4	105
	Def-Mid	15	4	101
	Sum	63 (13.1%)	12 (2.5%)	405 (84.4%)

Unlike the phrasing data, however, Korean processing data showed sensitivity to prosody. The percentage of high attachment was lower when the RC was short than when the RC was long or of the default length, and the percentage of high attachment was higher when the RC was sentence-initial than sentence-medial. These facts, i.e., the sensitivity to prosody in processing but not in phrasing, motivated me to re-examine Korean phrasing data to see if there are any subtle prosodic cues to prosodic grouping intended by Korean speakers, but not captured by the intonation model proposed in Jun (1993, 1998, 2000).

4. Intonation of Korean Revisited and Reanalysis of Attachment Data

4.1. Review of Korean phrasing data

The most common 'early' boundary of the 'RC NP1 NP2' structure was to produce the RC in one Intonation Phrase (IP) and each NP in an Accentual Phrase (AP). An example pitch track of this phrasing is shown in Fig. 2. The top tier in the figure shows Korean words following the rominization conventions in K-ToBI (Jun 2000), and the second tier shows tones representing AP and IP. Here, only the target structure, (*byEQwENe iBwENhaN doQryoU buiNIN* 'The wife of (my) colleague who is hospitalized') is shown. The full

sentence is shown in the figure caption, and the target structure, located in sentence-initial position, is underlined. The same format will be used in other pitch track examples in this article. As shown in the figure, the RC forms one IP and the NP1 and NP2 form another IP, each marked by a HL% boundary tone. The RC is 6 syllables long (default length) and has two words, each word forming one AP (i.e., 'L Ha' tone pattern). The second AP is the last AP of the first IP; thus, the AP final high tone (Ha) is overridden by the IP final HL% boundary tone. Similarly, NP1 and NP2 each forms one AP, but again the AP final high tone of the second AP, containing NP2, is overridden by the IP final boundary tone, HL%. Each IP final syllable is lengthened with HL% boundary tones, and the pitch is reset at the beginning of the second IP (*doQryoU*).

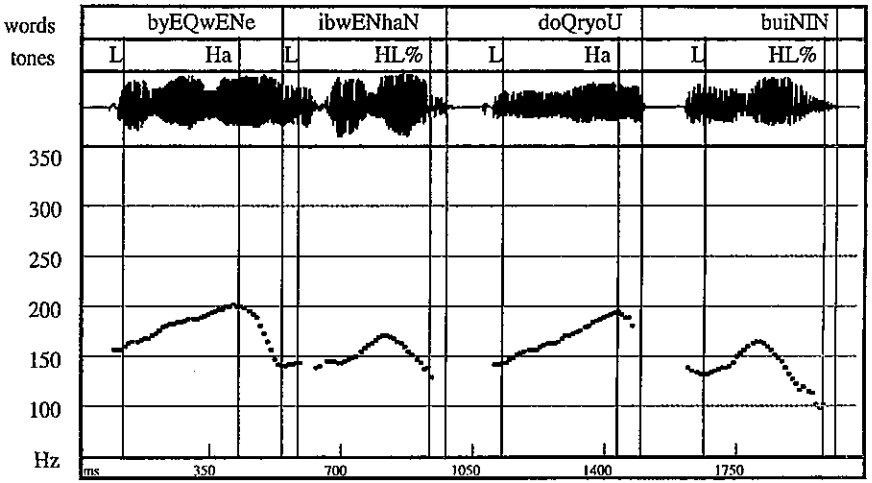


Figure. 2. Example pitch track of 'early' boundary: $(RC)_{IP}//((NP1)_{AP}(NP2)_{AP})_{IP}$
byEQwENe ibwENhaN doQryoU buiNIN ne doQseQU dehaG doQcaQ iEDta.
in the hospital hospitalized colleague's wife-TOP my sibling's college friend was
'The wife of (my) colleague who was hospitalized was my sibling's college friend.'

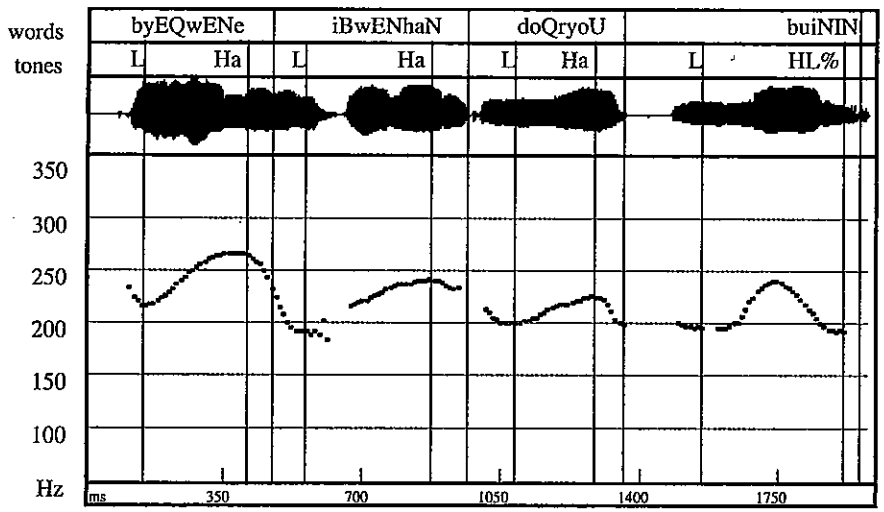


Figure 3. Example pitch track of 'neutral' boundary: $((RC)_{AP}(NP1)_{AP}(NP2)_{AP})_{IP}$. The sentence is the same as in Fig. 2.

The most common 'neutral' boundary of the "RC NP1 NP2" structure was to produce each word in an AP. An example pitch track of this phrasing is shown in Fig. 3. Here, the sentence is the same as that in Fig. 2. The whole target structure forms one IP and each word within the structure forms its own AP. Again, the AP-final high tone (Ha) of the last AP, containing NP2, is overridden by the IP final HL% boundary tone. Each AP-final high tone is lower than the preceding one, showing a sequence of downstep-like contour.

The lowering of Ha tones within an IP was also observed when all APs within an IP begin with a High tone, i.e., when the AP initial segments are aspirated or tense consonants, /h/, or /s/. Fig. 4 shows an example.

In Fig. 4, each word of the target structure (*sENgEe, chuRmahaN, sENbeU, chiNgunIN*) forms its own AP, and the tonal pattern of the first three APs is 'H Ha' because the initial segment is 's', 'ch', and 's', respectively, and each AP is shorter than four syllables (i.e., the middle L of HHLH is not realized). The last AP, having an aspirated initial segment ('ch'), also starts with a High tone, but its final Ha tone is not realized because its last syllable is also the last syllable of an IP which is lengthened and realized with a HL% boundary tone. As in Fig. 3, the Ha tone of each AP is lower than that of the preceding AP.

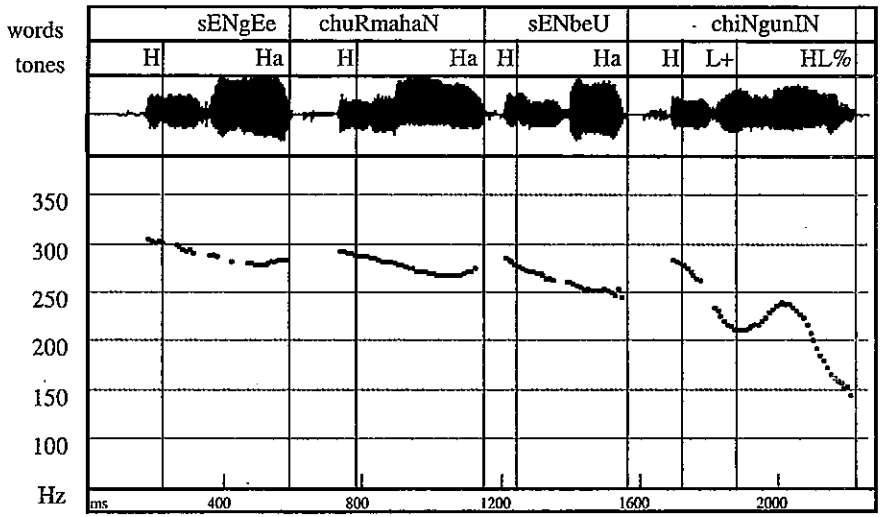


Figure 4. Example pitch track of 'neutral' boundary when all APs begin with an H tone.
sENgEe chuRmahaN sENbeU chiNgunIN dehaG sijEre uNdoQgwEniEDta.
in the election run-REL senior's friend-TOP in college political movement group- was
'The friend of (my) senior who ran in the election was a member of the political movement group in college.'

4.2. Korean intonation revisited

However, some of the 'neutral' boundary examples did not show the downstep-like F_0 lowering of Ha tones. Instead, the Ha tone of the AP containing NP1 was slightly higher than the preceding Ha, i.e., the tone marking the end of an RC, and this caused a bigger juncture between the RC and NP1 than the case where the Ha of the NP1 was lower than that of the preceding AP. An example pitch track illustrating this pattern is shown in Fig. 5.

The higher Ha tone of NP1 in Fig. 5 seems to have the effect of pitch reset shown in Fig. 2, thus triggering a bigger prosodic juncture than the default AP boundary. But this juncture was not large enough to be categorized as an IP boundary because the final syllable of the RC was not lengthened and did not have a boundary tone.

A larger than AP but smaller than IP juncture was also perceived when an AP begins with a higher pitch than the preceding AP, i.e., pitch reset, without phrase final lengthening of the previous AP. Fig. 6 shows an example. The sentence is the same as that in Fig. 4, and each AP begins with a High tone, but

the pitch range of the third AP (NP1: *sENbeU* 'senior's') is higher than that of the second AP, the second word of the RC (*chuRmahaN* 'to run-relative marker').

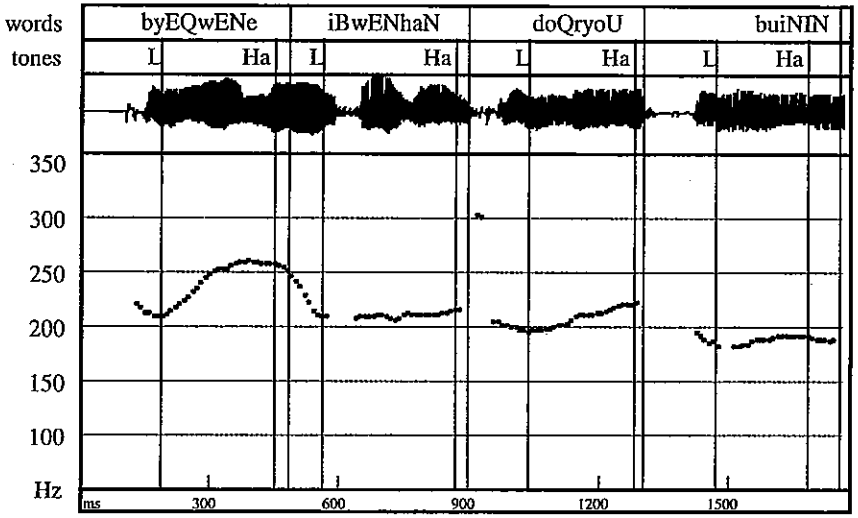


Figure 5. Example pitch track of the same sentence used in Figs. 2 and 3. The AP final tone, Ha, of NP1 (*doQryoU* 'colleague's') is higher than the preceding Ha, which marks the end of the RC. In this case, the boundary juncture between the RC and NP1 is larger than the default AP boundary.

So far, we have seen that a grouping of APs, which is smaller than an IP, is marked by pitch reset at the *beginning* of the group. The pitch reset was realized by a higher Ha tone or a higher initial H tone of the first AP of the group. However, other examples show that a grouping of APs is also marked by higher F_0 at the *end* of the group. That is, the Ha tone of the last AP of the group was higher than that of the preceding AP, functioning like a boundary tone of a larger group. Examples are shown in Fig. 7 and Fig. 8.

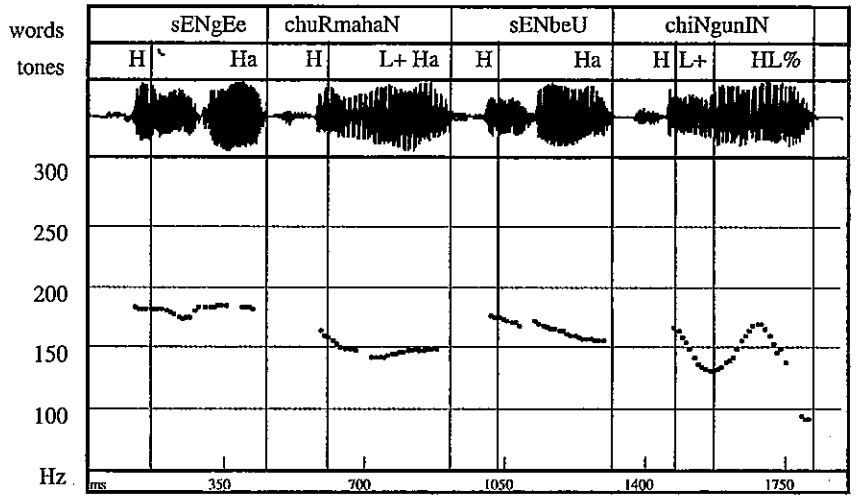


Figure 6. Example pitch track of the same sentence used in Fig. 4, but the initial tone of the third AP (NP1: *sENbeU* 'senior's') is higher than that of the preceding AP, which marks the end of the RC. The boundary juncture between the RC and NP1 is larger than the default AP boundary.

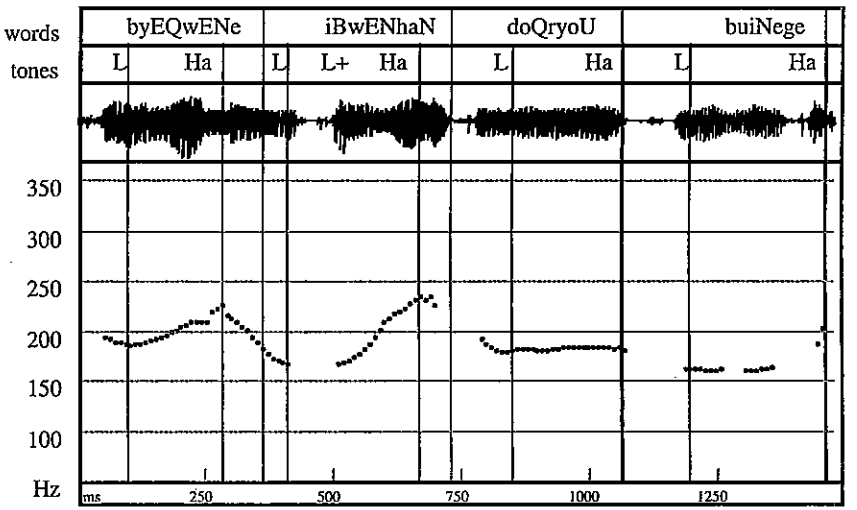


Figure 7. Example pitch track illustrating a larger than AP juncture with a higher Ha tone. The Ha tone of the second AP (the verb of the RC: *iBwENhan* 'hospitalized') is higher than that of the preceding AP, triggering a bigger juncture *after* the second AP.

UrinIN byEQwEne iBwENhaN doQryoU buiNege jENhwrIRheDta
we-TOP in the hospital hospitalized colleague's wife-DAT telephone-ACC did'
We telephoned the wife of (our) colleague who is hospitalized.'

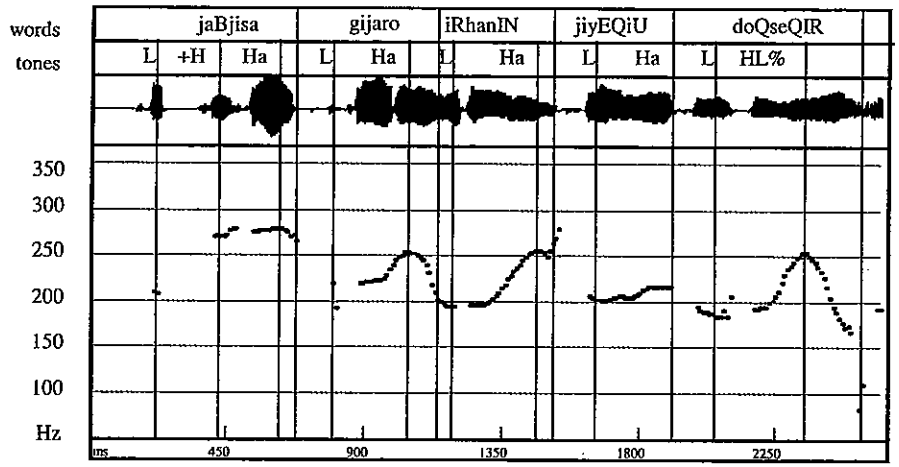


Figure 8. Example pitch track illustrating a larger juncture *after* the third AP (the verb of the RC: *iRhanIN* 'working'). The Ha of this AP is higher than that of the preceding AP.
jaBjisa gijaro iRhanIN jiyEQiU doQseQIR Eje sijaQesE maNnaDta
magazine reporter working Jiyoung's younger sibling-ACC yesterday at the market met
'Yesterday, at the market (we) met Jiyoung's younger sibling who is working as a magazine reporter.'

I will call this prosodic unit, which is larger than an AP but smaller than an IP, an Intermediate Phrase (ip), following the prosodic model of Japanese in Beckman and Pierrehumbert (1986) and Pierrehumbert and Beckman (1988).[6] This means that Korean intonation has three prosodic units above the Word: an Accentual Phrase, an Intermediate Phrase, and an Intonation Phrase, in ascending order in the prosodic hierarchy. As shown in the examples above, the intermediate phrase was defined by pitch range of APs, either marking the beginning of an ip by pitch reset or the end of an ip by a higher Ha boundary tone. However, using pitch range as a criterion does not work well if the APs do not begin with the same tone types. That is, declining F_0 peaks were visible only when all the target APs begin with L (LHLH type) or H (HHLH type). This is so because the first High tone of an HHLH type AP is much higher than the first High tone of an LHLH type AP (Jun 1996, 2000; Lee 1999). In other words, pitch range in Korean changes due to the AP-initial segment. This is the reason why pitch range had not been used as a criterion to define a prosodic grouping (e.g., Jun 1993). An example of higher pitch range due to an H-tone triggering segment at AP initial position is shown in Fig. 9. In this figure, the second AP (verb: *sirhEhanIN* 'hate-relative clause marker') has a larger pitch

range than that of the preceding AP because its first segment is 's' and the preceding AP's first segment is 'm'. Here, the juncture between the first AP (the subject of the RC: *maIR saraMdIri* 'village people') and the second AP (the verb of the RC) is not bigger than the default AP.

This suggests that defining an ip, based on pitch range, is reliable only when all the APs in the target structure begin with either L-tone type or H-tone type segments. Among the original target sentence tokens described in Section 3, 480 tokens satisfied this condition, and the prosodic phrasing of these tokens was reanalyzed by including an ip.

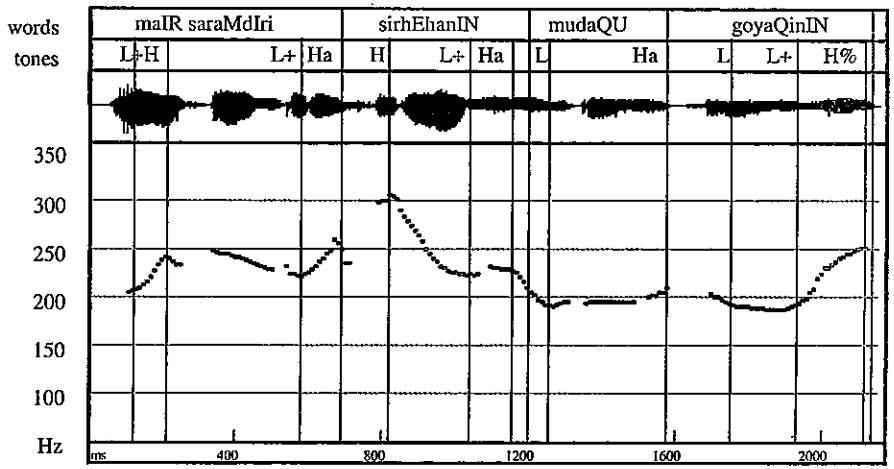


Figure 9. Example pitch track showing higher pitch range due to an H-tone triggering segment in an AP-initial position. See the second AP (*sirhEhanIN*). The English gloss of a full sentence, where the example phrase is from, is given below (the example phrase is underlined).
maIR saraMdIri sirhEhanIN mudaQU goyaQinIN baMmada doQnerIR baQhwaQhaNda
village people hate-REL exorcist's cat-TOP every night the village is wandering
'The cat of the exorcist that the village people hate is wandering the village every night.'

4.3. Reanalysis of attachment data

The prosodic phrasing of 480 sentences was categorized as 'early', 'late', and 'neutral' boundary based on the relative strength of the three prosodic units. That is, a boundary was categorized as an 'early' boundary if the phrasing is $(RC)_{IP}\ (NP1)_{ip\ or\ AP}$, $(RC)_{ip}(NP1)_{AP\ or\ no\ boundary}$, or $(RC)_{AP}(NP1)_{no\ boundary}$, i.e., the boundary after the RC is stronger than that after the NP1. A weaker boundary

after the RC than that after NP1, i.e., $(RC)_{ip \text{ or } AP}(NP1)_{IP}$, $(RC)_{AP \text{ or no boundary}}(NP1)_{ip}$, or $(RC)_{no\ boundary}(NP1)_{AP}$, was categorized as 'late' boundary, and an equal degree of boundary strength between the items, i.e., $(RC)_{IP}(NP1)_{IP}$, $(RC)_{ip}(NP1)_{ip}$, $(RC)_{AP}(NP1)_{AP}$, or $(RC\ NP1\ NP2)_{AP}$, was categorized as 'neutral' boundary. The frequency of each boundary type depending on the length of the RC is shown in Table 3. Data show that 'early' phrasing is the most common type of default phrasing in this limited data set: 53.9% of the data were produced with 'early' boundary, 2.7% with 'late' boundary, and 43.4% with 'neutral' boundary. In addition, the percentage of 'early' boundary was substantially higher when the RC was long than when it was not. This pattern, the common default phrasing and the effect of length on phrasing, is similar to that in Japanese.

Table 3. Percentage of default phrasing types for each length of RC in the limited data set where all APs in the target structure begin with either L-tone or H-tone type segments.

Length\phrasing	Early	Late	Neutral
Default	53.7%	0.8%	45.4%
Long	70.0%	1.6%	28.3%
Short RC	33.3%	3.3%	63.3%
Sum	53.9%	2.7%	43.4%

5. Discussion and conclusion

When the intonation pattern of Korean was reanalyzed by including the Intermediate Phrase (ip), defined by pitch range and a higher AP final boundary tone, more than half of the data showed an 'early' (RC//NP1 NP2) boundary, and a higher percentage of early boundary was found when the RC was long. Given that Korean speakers prefer high attachment and more high attachment was found when the RC was long, this pattern of default phrasing is what would be predicted by the Implicit Prosody Hypothesis. This was also true in Japanese data. This suggests that the default phrasing commonly produced by the speakers of language X is influenced by prosodic factors and is correlated with the attachment preference of the speakers of that language, thus indirectly supporting Fodor's IPH.

However, it should be pointed out that even though both Japanese and Korean data support the IPH by showing the overall correlation between phrasing and processing, i.e., more 'early' phrasing corresponds to more high attachment, the detailed pattern of phrasing and attachment data did not always go in the same direction. For example, the frequency of 'early' phrasing in Korean (after the reanalysis) was quite different among the three length types (Long RC> Default RC>Short RC). However, the percentage of high attachment was not different between Long RC and Default RC (Figure 1). Only Short RC showed significantly less high attachment than the other RC length types. Similarly, in the Japanese data, speakers produced more 'early' boundaries in the sentence-initial position than in the sentence-medial position, but there was no difference in attachment data due to the location.

Another issue raised from the Japanese data regarding the IPH is that the default phrasing (early, late, or neutral) can be influenced by the lexical prosody in the language. In Japanese, the accentedness of a lexical word affected the default phasing. Thus, when the RC is unaccented and the NP1 is accented, both tend to form one prosodic unit (i.e., accentual phrase), creating an 'early' boundary. On the surface, this type of boundary gives support to the prediction of the IPH (i.e., high attachment languages prefer early boundary). However, the IPH (which states that a default prosodic contour projected onto a sentence favors, other things being equal, the syntactic analysis associated with the default prosody for the construction) implies that there is a default prosody for a certain construction and this prosody is associated with a certain syntactic analysis. Then, what type of information of the construction determines its default prosody? If the prosody is determined by the construction, it would not be sensitive to the lexical property of the words forming the construction. However, the Japanese data suggest that the default prosody is influenced by anything that affects the prosody of the language. It is not just construction specific, but can be lexical item specific. It would even be possible to be segment specific. For example, a high tone triggering segment in Korean may trigger more prosodic breaks than a low tone triggering segment. A strong interpretation of the IPH would predict that the default phrasing in each language would predict the attachment preference regardless of whether the factors affecting the default phrasing be prosodic, lexical, or segmental. A weaker interpretation could be that there are some constraints on the factors affecting the phrasing related to the attachment preference. More languages with various prosodic features as well as the languages with a low attachment preference should be examined to investigate these issues.

Finally, this article suggests that Korean intonation has three prosodic units above the Word: an Accentual Phrase, an Intermediate Phrase, and an Intona-

tion Phrase, in ascending order in the prosodic hierarchy. Currently, the evidence of an Intermediate Phrase came from a limited set of data. The structure was RC NP1 NP2 and all words forming this structure began with L-tone type segments or with H-tone type segments, but not mixed. A further study is needed to define an Intermediate Phrase when a phrase is mixed with L tone-initial APs and H tone-initial APs. It is also necessary to examine different syntactic structures to fully define the criteria of the Intermediate Phrase

Notes

1. When the complex noun phrase comes sentence medially, the word before the noun phrase was mostly a topic noun (in four cases, a topic noun was preceded by a time adverb (e.g., yesterday)), but the word after the complex noun phrase varied in its syntactic category (a verb, a direct object, a complement noun, or a verbal adverb).
2. The Skim vs. No-skim group division is based on the subject's participation in the production experiment. Both groups had the same condition in the processing experiment. We wanted to see if skimming the sentences before reading would have any effect on processing the material three weeks later.
3. The target sentences were chosen from a pre-test where sixty sentences (15 sentences for each of the four categories: Long RC, Default-Sentence initial RC, Default-Sentence medial RC, and Short RC; See Table 2) were tested for their bias (on a 5 point scale) towards NP1 or NP2 attachment by thirty Korean speakers. Sentences with a similar preference (ratings of 3 or 4) for either NP1 or NP2 were chosen as the target sentences. Thus, any preference for NP1 or NP2, if found, would not be due to any syntactic or lexical bias towards NP1 or NP2.
4. As in Japanese, the long RC consists of multiple words and a short RC consists of a single word, a Verb with a relative clause inflectional morpheme.
5. In the sentence-medial position, the syntactic composition of material flanking the complex noun phrase was similar to that in Japanese. In addition, the variable, ACCENT, is not included for Korean because, unlike Japanese, all words in Seoul Korean are not accented at the lexical level. As shown in (6), an Accentual Phrase (AP) in Korean is defined by its tonal pattern marking the beginning and the end of the phrase, and the tonal pattern of each word is determined by the location of the word in an AP.
6. As mentioned in section 2.2, the IP in J_ToBI is the combination of B&P's Utterance and ip, so we could re-define the Korean IP by including the ip level, but I feel these two levels (IP and ip) are categorically different units because the IP-final syllable is substantially lengthened and optionally followed by a pause, while the ip-final syllable is not. Their degree of juncture corresponding to the break index would be quite different.

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