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Prosody in Sentence Processing: Korean vs. English[*]

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Abstract

This article presents the intonation system of Korean and English analyzed in the same theoretical framework (autosegmental-metrical phonology of intonation). The role of prosody in sentence processing is discussed focusing on the similarities and differences between the intonation systems of these two languages. Future research directions are suggested at the end.

1. Introduction

Prosody refers to a grouping within an utterance and the prominence relation among the members within the group. Groupings within an utterance, called prosodic units, are hierarchically organized so that a prosodic unit can include one or more smaller prosodic units. Since the grouping and the prominence relation among the members are often marked by intonation, the terms 'intonation' and 'prosody' are often used interchangeably. Intonation, though traditionally defined as the global changes in pitch over the course of a sentence or a phrase, has an internal structure. Some pitch events mark the boundaries between groupings, either small or large, while others mark the prominent member within a group. In this way, intonation contour marks a hierarchy of groupings and reflects the

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metrical structure of the group. The pitch events marking the internal structure of intonation can be represented by two distinct pitch levels, High (H) or Low (L) and their combinations (e.g., HL for falling and LH for rising). This view of intonation is known as an autosegmental-metrical model of intonation or intonational phonology, started in late 1970s and early 1980s through the seminal works of Bruce (1977) on Swedish intonation and Pierrehumbert and her colleagues on English intonation (e.g., Pierrehumbert 1980, Beckman and Pierrehumbert 1986, Liberman and Pierrehumbert 1986, Pierrehumbert and Hirschberg 1990).

This model of intonation has been applied to Japanese (Pierrehumbert and Beckman 1988) and Korean (Jun 1993), and has been expanded to many other languages including German (Grice and Benzmüller 1995) and Greek (see Jun 2005 for a similar analysis of eight other languages)[1]. As a phonological model, this model specifies only distinctive tonal events which are specific to each language or a dialect. Non-distinctive, i.e., predictable, tones are not specified. Syllables with no tonal target receive the pitch value by the interpolation of adjacent target tones (see Pierrehumbert and Beckman 1988 for the analysis of Japanese phrasal tone in an unaccented Accentual Phrase).

The categorical nature of this model made it possible for linguists to study the role of intonation in linguistics and to compare intonation across languages. Using the model of intonational phonology, we can analyze the intonation contour delivering different semantic and pragmatic meanings of a sentence and find out which prosodic feature is responsible for the different meanings. We can also manipulate these prosodic features in

[1] For most of these languages, a prosodic transcription system known as ToBI (Tones and Break Indices) has been developed based on the intonational phonology (i.e., tones) of each language and the prosodic groupings defined by the degree of juncture between words (i.e., break indices) (see Jun 2005, Chapter 2 for the history and the principles of ToBI).

investigating the role of prosody in sentence processing and other areas of linguistics. Measurements of acoustic features (fundamental frequency (f0) for pitch, duration, and intensity for amplitude) without knowing the category or structure of intonation can be misleading because the same phonetic value could be obtained from different phonological entities. For example, the high f0 of a syllable could indicate the prominence of the syllable or the boundary location of a phrase (Jun 2003). Describing the prosodic structure based on the auditory impression can also be misleading because providing objective criteria of the impression is not easy and also because the perception of acoustic features could be influenced by the researcher's native language. Now, due to easy access to high speed computers with large memory and speech analysis software, more researchers are attempting an instrumental investigation of speech material.

The organization of this paper is as follows. In Section 2, I will present the intonation system of Korean and English and describe the similarities and differences between these two languages. Comparing the intonation systems of these two languages is possible and reliable because they are analyzed in the same theoretical framework. In Section 3, I will discuss the role of prosody in sentence processing focusing on the similarities and differences between the two languages. Then, I will conclude the paper by suggesting future research directions.

2. Intonation of Korean and English

2.1 Intonation of Korean

The intonational phonology of Korean proposed in Jun (1993, 1998) and the Korean ToBI (Tones and Break Indices) model, a transcription system of intonation and phrasing,

reported in Jun (2000)[2] posit two prosodic units above the Word: an Intonation Phrase (IP) and an Accentual Phrase (AP). An IP can have one or more APs which can in turn have one or more Word. An IP is defined by phrase final lengthening and a boundary tone, realized on the last syllable of the phrase. It is optionally followed by a pause. An AP is defined by a phrasal tone (LHLHa or HHLHa) marking the beginning and the end of the phrase (in Korean ToBI, the AP final tone is transcribed with a diacritic 'a' (e.g., Ha), reflecting the function of the AP boundary marker). An AP has no phrase-final lengthening and is not followed by a pause. The end of an AP is marked by a rising tone (LHa), realized on the last two syllables of the phrase (L on the penult and Ha on the final syllable). The beginning of an AP is marked by either a rising tone (LH) or a high plateau (HH) on the two phrase-initial syllables. The tone on the phrase initial syllable is H when the syllable begins with a tense or aspirated consonant, /h/, or /s/; and L otherwise. The H tones on the AP initial syllables, i.e., the first two Hs in HHLHa, are realized much higher than the H tone after an L tone, i.e., the first H in LHLHa (Lee 1999). These tone patterns are fully realized when an AP has four or more syllables, but when it has three or fewer syllables, the medial L or H or both is undershot, resulting in a simple rise (LHa), an early rise (LHHa), or a late rise (LLHa) pattern for the case of L-initial APs, and a high plateau (HHa) or a fall-rise (HLHa) pattern for the case of H-initial APs. The AP final tone is in general High, but is sometimes (11%; data from S. Kim 2004) realized as Low before an H-initial AP or before an IP-final AP with a L% boundary tone, resulting in a falling (HLa, HLLa, or HHLa), a low plateau (LLa), or a rise-fall (LHLa) AP pattern.

[2] The manual of Korean-ToBI conventions and associated sound files are accessible in http://www.linguistics.ucla.edu/people/jun/ktobi/K-tobi.html

The tones marking an AP are phrasal tones and are not linked to words within a phrase. Thus, the tonal shape of a word changes depending on its location within an AP. For the same reason, a word initial segment will affect the AP initial tone only when the word comes at the beginning of an AP, but not when it comes in the middle of an AP. In general, an AP contains 3-4 syllables, and when it has more than 6 syllables forming two words, it splits into two APs (Jun 2003b, S. Kim 2004). Thus the most common AP contains only one Word (Schafer and Jun 2000, 2002; S. Kim 2004). When a word is contrastively focused, an AP boundary is deleted, i.e., dephrased, between words after focus. In that case, an AP can contain multiple words.

However, the degree of juncture before the focused word is larger than that before the default AP boundary and smaller than that before the default IP boundary. The pitch range of the focused phrase is much larger than that of a default AP, and the phonetic realization of the focused phrase initial segment is stronger than that of a default AP, reflecting the hierarchy of the prosodic units based on the degree of phrase initial strengthening (Jun 1993, Fougeron and Keating 1997, Cho and Keating 2001). Because of this, and based on data from sentence processing (Jun and Kim 2004), Jun (2004) revised the earlier model and proposed a prosodic unit between an IP and an AP, called 'an Intermediate phrase (ip)'.

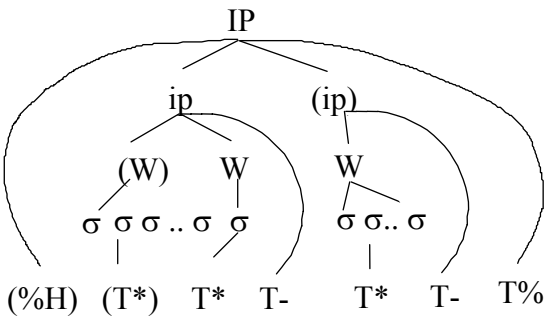
An ip in general contains two or three APs, and is defined by either a higher AP final boundary tone or by a pitch reset among APs, or both. It shows no or small degree of phrase-final lengthening compared to that of AP. It is found that the edge of syntactically heavy constituents such as a small clause or a heavy XP (e.g., NP, VP) are often marked by an ip boundary, and a large clause boundary is more often marked by an

IP boundary. APs within an ip show a downstep-like relationship. That is, the f0 peak of an AP is lowered compared to that of the preceding AP, and the downstep chain is broken, i.e., pitch is reset, at the beginning of a new ip. This is, however, observed only when all the APs within an ip begin with the same type of tone, either H or L triggered by the segment type. Further research is needed to define a more general criterion of an ip.

2.2 Intonation of English

The intonational phonology of English proposed in Beckman and Pierrehumbert (1986) and the English ToBI transcription system summarized in Beckman and Ayers (1994) posits two prosodic units above the Word: An Intonation Phrase (IP) and an Intermediate Phrase (ip). An IP is the highest prosodic unit defined by intonation and can contain one or more Intermediate Phrases. The intonation structure of English is shown in (1). An IP is marked by a boundary tone (T% in (1), meaning L% or H%), realized on the phrase final syllable, and an optional High tone at the beginning (%H), realized on the phrase initial syllable. It is also marked by phrase final lengthening and is optionally followed by a pause. An ip must contain at least one pitch accent (T*), prominent pitch realized on a stressed syllable, and is marked by phrase accent (T-, meaning L- or H-), realized over syllables right after the last pitch accented word up to the last syllable of an ip.

(1) Intonational structure of English (adapted from Beckman and Pierrehumbert, 1986).



There are five pitch accent types proposed in English ToBI: L*, H*, L*+H, L+H*, H+!H* (plus downstepped High tones, i.e., !H*, L+!H*, L*+!H).[3] Any pitch accent, except when a downstepped H pitch accent is the first H tone in the phrase (e.g., !H*, L+!H*), can come at the beginning of an ip. The starred tone is realized on the stressed syllable of a word, 'W' in (1), and the tone preceding or following the starred tone (L in L+H* or H in L*+H) is realized immediately preceding or following the stressed syllable. Therefore, the f0 peak in L+H* is realized earlier than the f0 peak in L*+H.

Pitch accent is associated with the stressed syllable of the semantically and pragmatically prominent word in a sentence, and the type of pitch accent delivers the meaning of the pitch accented item in the discourse (Pierrehumbert and Hirschberg 1990). Though every word has stress, not every word receives pitch accent. Whether a word receives pitch accent or not is determined postlexically based on the meaning of the utterance. This is different from the pitch accent in Tokyo Japanese where there is only one type of pitch accent (H*+L) and pitch accentedness is a lexical property of a word. Since not every word in English receives pitch accent, words without pitch accent are not specified with a tone, and the pitch values on these words are determined by interpolating the tonal target of the adjacent pitch accent.

In English, the last pitch accent of an intermediate phrase is the most prominent pitch accent within an ip, and is called the nuclear pitch accent (NPA). That is, an ip is the domain of the NPA. An ip is also the domain of the NPA derived from focus. When a

[3] There were six pitch accent types in Beckman and Pierrehumbert (1986): L*, H*, L+H*, L*+H, H+L*, H*+L. But H+L* became H+!H* in ToBI to reflect the mid level f0 value of L* in H+L*. H*+L was merged to H* because the downstep trigger (i.e., +L) was no longer needed by adding an explicit downstep marker (!) before a High tone.

word is contrastively focused, the word receives an NPA and the pitch accent of all post-focus words (if existed in the neutral production of the utterance) is deleted, i.e., deaccented. The words preceding the focused word also show signs of reduced prominence. They either lose their pitch accent or are produced in a reduced pitch range. The focused word is produced with an expanded pitch range, higher amplitude, and longer duration, and sometimes separated by a pause before and/or after the focused word. Finally, an ip is the domain of downstep. That is, pitch range is reset across an ip boundary.

2.3 Similarities

The prosodic system of Korean and English is similar in a few aspects. Both languages have at least two prosodic units above the word, and they are marked by intonation. The IP in each language is marked similarly, by phrase-final lengthening, an obligatory boundary tone, and an optional pause following an IP. Though the number of boundary tones is far fewer in English, some of the sentence types are marked by the same boundary tones. For example, yes/no questions are marked by a high boundary tone while declaratives and imperatives are marked by a low boundary tone.

Though the Korean AP is a prosodic unit larger than a Word, its function of marking new/old information is similar to that of the English pitch accent. In Korean, a word with new information comes at the beginning of an AP and a word with old information tends to come in the middle of an AP (H. Kang 1996). In English, a word with new information receives pitch accent and a word with old information tends not to receive pitch accent.

The realization of focus is also similar in both languages. Pitch range is expanded during the focused word and reduced after focus. In Korean, AP boundaries are deleted after focus, i.e., dephrasing, and in English, pitch accent is deleted after focus, i.e., deaccenting. The domain of dephrasing or deaccenting is an intermediate phrase in both languages (assuming the revised model of Korean intonation).

2.4 Differences

One of the biggest differences between English and Korean prosody is that English is a lexical stress language and Korean is not. In English, the prominence of a word is cued by pitch accent which is associated with the stressed syllable of the word. In Korean, the prominence of a word is achieved by placing the word at the beginning of a phrase. Thus, English is known to be a 'head' prominence language and Korean an 'edge' prominence language (Jun 2005, Ch. 16).

Though the Intonation Phrase is defined similarly in English and Korean, the smaller phrase is not. The ip in English has phrase-final lengthening, though not as long as in the case of IP. The ip or AP in Korean has no substantial phrase-final lengthening. The ip in English is marked by the phrase accent whose realization is not localized on the phrase final syllable, but covers any syllables between the last pitch accented word and the end of the phrase. However, it is not clear if there is any tone specific to an ip in Korean. It is defined by pitch reset, i.e., the interaction of pitch height between APs. The AP in Korean is defined by phrasal tones marking both the beginning and the end of the phrase. Having two tones (H or L) at the beginning of an AP depending on the phrase initial segment type is unique to Korean intonation. Since most words form one AP by

themselves in Korean (Schafer and Jun 2002, S. Kim 2004), the association of a tone with a word-initial segment is perceptually very salient (Cho 1996, Kim *et al.* 2002).

Finally, the pragmatic meaning of a sentence is delivered by the IP boundary tone realized on the phrase final syllable in Korean but by the whole intonation contour in English, i.e., from the combined meaning of pitch accent, phrase accent, and boundary tone. For example, one of the functions delivered by a LHL% boundary tone in Korean is annoyance or irritation. In English, this meaning is achieved by a sequence of L* pitch accent, H* pitch accent, and L-L% boundary tones.

3. The role of prosody in sentence processing

Given the similarities and differences in prosody of English and Korean, there are similarities and differences in the way prosody influences sentence processing in two languages. For many spoken sentences in each language, prosodic structure helps to resolve ambiguity at other levels of linguistic analysis. For example, the English sentence in (2) can mean either (a) or (b) depending on the prosodic phrasing of the utterance: a prosodic boundary comes after *the girl* in (2a), but before *the girl* in (2b). Similarly, the Korean sentence in (3) means (3a) if a prosodic boundary comes between *Soyengi* 'Soyeng-NOM' and *pap* 'a meal' but means (3b) if there is no boundary in that place.

(2). The hostess greeted the girl with a smile (Lehiste 1973)

a. The hostess greeted the girl // with a smile => The hostess smiled

b. The hostess greeted // the girl with a smile => The girl smiled

(3) Soyengi pap mekessni? 'Soyeng-Nom a meal eat-interrogative ending'

(a) Soyengi // pap // mekessni "Soyoung, did you eat your meal?"

(b) Soyengi pap // mekessni "(Did you) eat Soyoung's meal?"

As shown in (2) and (3) above, an intended syntactic and semantic structure in each language is cued by the prosodic phrasing of the sentence. Accordingly, it has been found that when the boundary of a prosodic unit comes at a place corresponding to a syntactic/semantic group, native speakers of each language take less time in processing the sentence/phrase compared to the case where the prosodic boundary does not match the syntactic/semantic boundary (e.g., Warren *et al*. 1995, Schafer 1997, Kjelgaard and Speer 1999, Speer *et al.* 1999, Schafer *et al.* 2000 for English; Schafer and Jun 2000, 2002, Kang and Speer 2003, H.-S. Kim 2004, for Korean). For example, in a cross-model naming task where subjects complete a sentence after hearing a sentence fragment and seeing a target word (the word immediately following the sentence fragment) on a computer screen, Kjelgaard and Speer (1999) found that, when the target word is *is*, English speakers complete the sentence fragment shown in (4) much faster, i.e., process faster, when an Intonation phrase boundary comes after the verb *leaves* than after the noun *the house*.

(4) When Roger leaves the house

Similarly, in a cross-model naming task, Schafer and Jun (2000, 2002) found that native speakers of Korean process a noun phrase (Adjective+NP1+NP2; e.g.,

hyenmyenghan akiuy appa ‘ wise baby’s daddy’) faster when the accentual phrasing of the noun phrase matches the semantic/pragmatic meaning of the phrase (e.g., wise // baby’s daddy) than when it does not match (e.g., wise baby’s // daddy). This study shows that Korean speakers are sensitive to the existence of an AP boundary in sentence processing even though, unlike the Intonation Phrase (or the Intermediate Phrase) in English, the Korean AP has no consistent final lengthening. As found in Kim and Lee (2004), prosodic phrases realized with strong acoustic cues such as an Intonation Phrase exert more influence in sentence parsing than those marked by weaker acoustic cues. Thus, the English ip and IP, where boundaries are marked by phrase-final lengthening in addition to the tonal cue, behave similarly in sentence processing, but the Korean AP and IP, where only the IP is marked by phrase-final lengthening, do not, i.e., an IP has stronger influence than an AP on sentence processing.

Schafer and Jun’s finding that prosodic phrasing in Korean disambiguates a syntactically ambiguous string was confirmed by more recent studies where the domain of ambiguity was larger. Kang and Speer (2003) showed that a globally ambiguous sentence like (5) is disambiguated by prosodic phrasing. Two possible meanings are shown in (5a) and (5b)

(5) Cinwen-ika ywupaytangha-n sancang-ul kongkyekhaysse.

‘Cinwen-NOM got-exiled-REL villa-ACC attacked’

a. “Cinwen attacked the mountain villa where (pro) got exiled.”

b. “(pro) attacked the mountain villa where Cinwen got exiled.”

When there was no Intonation Phrase boundary after the subject NP *Cinwenika* (thus the subject NP and the following verb form one prosodic unit), speakers overwhelmingly chose the subject NP (82.6%) as the subject of the verb, *ywupaytanghan*, i.e., interpreted the sentence as (5b).

Hee-Sun Kim (2004) also showed the role of prosodic phrasing in disambiguation of a larger phrase. She investigated whether a temporarily ambiguous string shown in (6), *nanun kkochul coahanun mincieykey*, is produced differently depending on the two different structures/meanings of the sentence, i.e., (6a) and (6b), and whether speakers *use* prosody to process the different interpretations. (6a) is named the SR reading where the second word, *kkochul* 'a flower-ACC', is the object of the relative clause, and (6b) is named the SOR reading where the second word is the object of the main clause. She found that the ambiguous string is disambiguated by different prosodic phrasing: an IP break after 'I-top' and an AP break after 'a flower' for the SR reading, and an AP break after 'I-top' and an IP break after 'a flower' for the SOR reading. Subjects processed the sentence significantly faster when the prosodic phrasing matched the intended meaning of the structure than when not.

(6) nanun kkochul coahanun mincieykey ↗ cangmilul cwuessta (a)
↘ cwuessta (b)

'I-top flower-ACC like-rel Minci-DAT a rose gave (6a) /gave (6b)'

a. SR reading: I gave the rose [to Minci who likes flowers]

b. SOR reading: I gave [the flowers] [to Minci whom e_i like]

Thus, English and Korean are similar in manipulating prosodic phrasing to deliver the intended meaning and structure of a sentence and in paying attention to prosodic phrasing cues in processing the different meanings.

On the other hand, English and Korean differ in the use of prosodic features and the meaning when focusing a wh-pronoun. Schafer, Carlson, Clifton, and Frazier (2000) found that when a wh-word is focused, i.e., nuclear pitch accented, as in a sentence (7a), the wh-word is interpreted as an embedded question interpretation whereas the absence of pitch accent on the wh-word as in (7b) biased listeners to a relative clause reading.

(7) a. I asked the pretty little girl WHO is cold

b. I asked the pretty little girl who is COLD.

The same meaning as (7a) is achieved in Korean by placing the wh-word at the beginning of an Accentual Phrase and erasing the Accentual Phrase boundary after the wh-word, as shown in (8a). If the AP boundary after the wh-word is maintained as in (8b), the wh-word is interpreted as an indefinite pronoun as described in Jun and Oh (1996). The meaning of (7b) is not possible in Korean without changing the word order and the structure.

(8) nanun yeyppun sonyeeykey nuka chwupnyako mulessta.

'I-TOP pretty little girl who cold asked'

a. {nanun} {yeyppun} {sonyeeykey} {nuka chwupnyako} {mulessta}.

=> "I asked the pretty little girl WHO is cold"

b. {nanun} {yeyppun} {sonyeeykey} {nuka} {chwupnyako} {mulessta}.

=> "I asked the pretty little girl if there is anyone who is cold"

4. Future research

Studies examining the role of prosody in sentence processing are relatively new in the field of psycholinguistics. To better understand the mechanism of auditory sentence processing in general and specific to Korean, prosody of more various syntactic structures and with different pragmatic conditions should be examined, using various methodologies. Further, we need to refine the intonation model of Korean to describe the prosodic phrasing and the tonal pattern of the utterances in the production experiment and to manipulate the prosodic features in the processing experiment. This will also allow us to pursue syntax-prosody interface studies (e.g, Jun 1998).

Studies on sentence processing have investigated the mechanism of sentence processing by adult native speakers of Korean. A natural extension of this is to investigate the acquisition of Korean prosody by children (as well as by the second language learners of Korean) and how prosody guides parsing of a word and of a sentence boundary in Korean (see Jun and Oh 2000, Choi 2003, S. Kim 2004, cf. Jusczyk , Cutler, and Redanz 1993, Jusczyk 1999). Most studies on first language acquisition have been focusing on the area of morphosyntax and phonology, but rarely on the area of prosody. It is known that children acquire intonation before they acquire words (Lewis 1951, Crystal 1979). Acquiring a different boundary tone for a different sentence type (e.g., Low tone for a declarative or High tone for an interrogative) could be easily observed, but a careful study is needed to investigate the pragmatic meaning of

different boundary tones (e.g., Park 2003) and the acquisition of prosodic phrasing (e.g., Choi 2003, Choi and Mazuka 2003, this volume).

In sum, prosody plays an important role in the area of psycholinguistics as well as other sub-areas of linguistics, and analyzing intonation in the framework of intonational phonology provides a useful tool to compare prosodic features across languages and to manipulate the prosodic features within a language. Further research is needed to explore the processing of prosody and the role of prosody in processing.

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