

ToBI Based Prosodic Representation of the Kyungnam Dialect of Korean

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ABSTRACT

This paper proposes a prosodic representation system of the Kyungnam dialect of Korean, based on the ToBI system. In this system, diverse intonation patterns are transcribed on the four parallel tiers: a tone tier, a break index tier, an orthographic tier, and a miscellaneous tier. The tone tier employs pitch accents, phrase accents, and boundary tones marked with diacritics in order to represent various pitch events. The break index tier uses five break indices, numbered from 0 to 4, in order to represent degrees of connectiveness in speech by associating each inter-word position with a break index. In this, each break index represents a boundary of some kind of constituent. This system can contribute not only to a more detailed theory connecting prosody, syntax, and intonation, but also to current text-to-speech synthesis approaches, speech recognition, and other quantitative computational modellings.

Keywords: ToBI, intonation, prosody, break, tier

1. Introduction

For the development of computational models such as high quality text-to-speech synthesis and spoken language perception systems, large corpora for spoken language, which are annotated in some way, are required. However, orthographic transcriptions or syntactic annotations of speech signals have limited capabilities representing many different ways of uttering an identical string of words, for example. Consequently, a robust system of prosodic representation which can describe much of the alteration in speech signals and which can convey much of the information necessary to retrieve intonational meanings will be particularly important for significant process in computational modelling of speech signals.

Motivated by this view, Silverman et. al. (1992) and Pitrelli et. al. (1994) developed ToBI

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(**Tone and Break Indices**) system to represent prosodic aspects of most varieties of American English, and aimed at using ToBI as a standard for prosodic transcription of speech signals in order to share large amounts of prosodically transcribed speech across research sites in the pursuit of diverse research purposes.

This paper examines the intonation patterns, affected by different focus loci, of the Kyungnam Dialect of Korean (KNDK hereafter) (spoken in the southeastern part of Korea) and develops a prosodic representation system which makes it possible to characterize different intonation patterns of a given string of words, based on the ToBI annotation conventions and Cho's frameworks (1996, 1997).

The organization of this paper is as follows: first, the ToBI system is overviewed; second, a prosodic representation system suitable for the description of KNDK is explored; third, the system is applied to KNDK utterances which are affected by the different focus loci, and finally, a direction of further study will be suggested.

2. Overview of the ToBI System

A group of researchers including Silverman et. al. (1992) and Pitrelli et. al. (1994) devised and developed a ToBI system which prosodically transcribes diverse utterance types of English on four parallel tiers: an orthographic tier, a miscellaneous tier, a break index tier, and a tone tier. Among these four tiers, the orthographic tier and the miscellaneous tier are not part of the major prosodic analysis. The orthographic tier is a direct transcription of all words in the utterance, in ordinary English orthography, and the miscellaneous tier is a comment tier which can be used to mark events such as coughing, laughter, and sneezing which disrupt the smooth rhythm of the utterance. The break-index tier and the tone tier, however, represent the major prosodic analysis.

2.1 The Tone Tier

The tone tier is most closely related to Pierrehumbert's (1980) phonological analysis of the intonation patterns of utterances. It employs five pitch accents, two phrase accents, and two boundary tones marked with diacritics in order to represent various pitch events.

Pitch accents have two single-tones, H* and L*, and three complex tones, L**H, L+H*, H+!H*. The diacritic * indicates that the tone is aligned with an accented syllable and the unstarred tone of a bitonal accent precedes or follows it at some given space in time. H* is a peak accent which represents a high pitch value and is aligned with the accented syllable. L* is a low accent which aligns with the accented syllable and represents the speaker's

lowest pitch range. L*+H is a scooped accent which represents a rise from a low pitch into a peak that occurs much later, making the low tone align with the accented syllable. L+H* is a rising peak accent which represents a rise from a low pitch into a peak, making the high tone align with the accented syllable. The difference between the scooped L*+H accent and the rising peak L+H* accent is that the rise occurs much later in the scooped accent, resulting in a different association of starred tone to the accented syllable. H+!H* accent corresponds to Pierrehumbert's H+L* accent which represents a fall from a preceding higher pitch onto a lower pitch level on the accented syllable. In the H+!H* sequence a high pitch is not associated with a phrasal H tone or a preceding H pitch accent in the same phrase. When there is an accented syllable in an utterance, it is associated with one of the above five pitch accents. When none of the pitch accents are assigned to a syllable, it means that the syllable is not accented.

· Phrase accents are transcribed as high (H) or low (L) with a diacritic - and they are associated with intermediate intonation boundaries. Accordingly, pitch accents followed by a phrase accent forms an intermediate phrase.

Boundary tones are H% and L%, where H and L tones are represented with a diacritic '%' which indicates the association of a tone with a full intonation boundary. However, every full intonation phrase boundary is represented by a boundary tone immediately preceded by a phrase accent as in L-L%, L-H%, H-H%, and H-L%, but not just by a single boundary tone. This notation is to indicate that the right edge of a full intonation boundary coincides with the right edge of an intermediate phrase boundary since intonation phrases are composed of one or more intermediate phrases. Thus, a L-L% sequence represents a full intonation boundary with a L phrase accent marking the edge of its intermediate phrase and a L% boundary tone marking the fall of F₀ to the low of the speaker's pitch range and the end of its full intonation phrase. This label is used for typical declarative contours of American English. In a L-H% sequence, a L- phrase accent marks the edge of its intermediate phrase and a H% boundary tone represents a rise at the end of a full intonation boundary as in a continuation rise. A H-H% sequence represents contours like the canonical 'yes-no question' contour where a H- phrase accent causes upstep on the following H% boundary tone and the boundary tone represents a great pitch rise at the end of an utterance. In a H-L% sequence, the phrase accent H- upsteps the L% to the middle of the speaker's pitch range, resulting in a final plateau pitch contour.

2.2 The Break Index Tier

The break index tier uses five break indices, numbered from 0 to 4, in order to

represent degrees of connectiveness in speech by associating each inter-word position with a break index, and each break index represents a boundary of some kind of constituent as shown in (1).

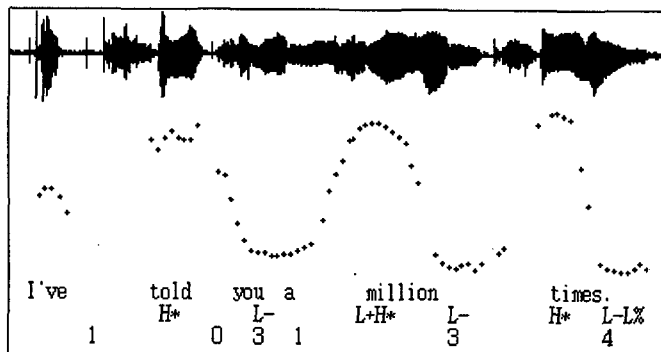
(1) The Break-Index System of ToBI

- 0 - clear phonetic marks of clitic groups
- 1 - most phrase-medial word boundaries
- 2 - disjuncture marked by a pause, but without tonal marks
- 3 - intermediate phrase boundary
- 4 - full intonation phrase boundary

In (1) smaller break indices represent smaller disjuncture (tight coupling) between adjacent words, and bigger break indices represent stronger disjuncture between adjacent words. Among the five break indices, break index 0 is the lowest-level break index which is used for connected-speech processes such as a flap in *hit it* and is defined as the clear phonetic marks of clitic groups. Break index 1 is used for most phrase-medial word boundaries and is encountered the most frequently. Break index 2 is used to represent a strong disjuncture at a boundary between two words where a well-formed tune continues across the juncture, or a disjuncture weaker than an intermediate or intonation boundary. Break index 3 marks an intermediate intonation boundary and is aligned with either a L- or H- phrase accent on the tone tier. Finally break index 4 represents a full intonation phrase boundary and is aligned with a terminal boundary tone on the tone tier.

Figure 1 shows how the break indices and tone labels are represented for the utterance '*I've told you a million times*'.

Figure 1. F₀ contours for the utterance '*I've told you a million times*'.



3. A Prosodic Representation System of KNDK

3.1 Break Indices and Tone Labels in KNDK

The lowest-level break index 0 is defined in terms of connected speech processes, such as flapping of /t/ in *hit it* or palatalization of /t/ in *get you* in English. In the case of KNDK, the break index 0 can be marked between nouns and markers such as in nominative case markers (-i, -ga, -nən, -ən), accusative case markers (-rəl, -əl), dative case markers (-ege), focus markers (-man), and so on. Unlike English, it doesn't have to involve phonetic processes to mark the break index 0 between a noun and a marker because nouns and markers are closely connected in speech. In Figure 2a, the break index 0 is marked between the pronoun *ne* 'I' and the nominative marker *-ga*, and there is no clear segmentation of speech signal between the pronoun and the case marker. Though the break index 1 can be marked between the boundary of *hit* and *it* depending on the speaking rate in English, the break index 1 is unlikely to be located between a noun and its marker in KNDK.

The break index 1 can be marked between individual word boundaries which do not show a clear disjuncture. In Figure 2c, there is no disjuncture between the noun *turumagi* 'overcoat' and the postposition *boda* 'than', and the break index 1 is marked to indicate the boundary between these two words.

The break indices 3 and 4 are used to mark the intonational categories, such as the accentual phrase and the full intonation phrase. Accentual phrase (The accentual phrase has been designed to describe the tonal phenomena of Japanese by Pierrehumbert & Beckman (1988). And Jun (1993) proposes a number of reasons to use accentual phrase in Korean instead of phonological phrase which is proposed by Selkirk (1984, 1986).) in KNDK is the smallest prosodic unit that can be defined in terms of the intonation pattern of an utterance: in most cases, only one accent can occur in an accentual phrase, and its boundary is marked by the break index 3. As for an intonational phrase, it may consist of one or more accentual phrases, and its edge is marked by the break index 4. Thus, whenever there is a break index level 3, a corresponding tone label, either L- (a low phrase accent) or H- (a high phrase accent), aligns with it. Similarly, whenever there is a break index level 4, a corresponding tone label, either L% (a low boundary tone) or H% (a high boundary tone), aligns with it. Figure 2d illustrates the placement of break indices 3 and 4, and corresponding tone labels for the utterance given in (2).

- (2) omma-ga manəl-əl mutta.
 mother-Nom. garlic-Acc. ate
 'Mother ate garlic.'

As this figure shows, the boundary between the first accentual phrase and the second accentual phrase, and the boundary between the second accentual phrase and the third accentual phrase are indicated by a deep F_0 valley. For each F_0 valley, the break index 3 is marked and a corresponding phrasal tone, L^- , is labeled. However, the break index 3 is not marked at the right edge of the third accentual phrase. Instead, the break index 4 is marked because the edge of the third accentual phrase coincides with the edge of the intonational phrase and the highest break index level 4 supersedes the break index level 3. Though the use of break index 4, indicating the intonational phrase boundary, is the same as in English, the tone labeling of the intonational phrase boundary is different from English. While KN DK requires a single terminal boundary tone, such as $L\%$ or $H\%$, to represent an intonational phrase boundary, English requires a dual tone - a phrasal accent followed by a terminal boundary tone, e.g., $L-L\%$. This notation is motivated by Pierrehumbert and her collaborators due to the fact that the edge of the intermediate phrase (equivalent to accentual phrase in KN DK) boundary coincides with the end of the intonational phrase. According to this notation, a boundary tone stays at the intonational phrasal boundary and the phrasal tone fills the space between the last pitch accent and the intonational phrase boundary. For example, if the intonational phrase boundary is labeled $L-L\%$ and the nuclear accent is far from the end of the intonational phrase, the L^- phrase tone creates a flat low spreading from the nuclear accent to the end of the intonational phrase boundary. However, KN DK does not need a dual tone convention because the tonal contour from the nuclear accent to the terminal boundary tone can be explained in terms of interpolation (Cho 1994). The avoidance of a dual tone convention is the same as not marking the break indices 3 and 4 at the same time (for example, 3-4) at the end of the intonational phrase to represent the coincidence of the accentual phrase and the intonational phrase.

So far, break indices 0, 1, 3, and 4 have been considered, and they seem to correspond to the degree of disjuncture of different kinds of prosodic grouping. However, the subjective impression of boundary disjuncture does not always correspond to intonational constituency. In order to deal with the mismatch between the subjective boundary strength and the intonational constituency, the break index 2 was devised. If we take the phrase *abuci-ty mam* 'father's thought', shown in Figure 2b, for example, there is an F_0 valley between the possessive noun and the head noun. This disjuncture is not caused by hesitation or disfluency. However, the perceived disjuncture is weaker than the disjuncture perceived in between accentual phrase boundaries or at the end of the intonational phrase. In this case, we can use the break index 2 to represent a phrase internal disjuncture. This treatment draws one of a few exceptions to the argument that an accentual phrase may take only one peak in its domain.

Although ToBI uses the *p* diacritic after the break index level, such as 1p, 2p, or 3p, to represent an abrupt cutoff, restart of some part of an utterance, or a hesitation pause, the current study in this paper does not extend to the use of *p* diacritic.

To summarize, the break index system which accommodates the tonal phenomena of KNDK, the break index system proposed by ToBI is slightly modified as shown below:

- (3) Break Indices in KNDK
- 0 - boundary within a clitic group
 - 1 - most phrase-medial word boundaries
 - 2 - phrase-internal disjuncture
 - 3 - accentual phrase boundary
 - 4 - intonational phrase boundary

3.2 Accentual Prominence and Its Representation

Beckman & Pierrehumbert (1986) propose that tonal phenomena in English be described in terms of the notion "accent", which serves to mark the lexical item with which they are associated as prominent. In the marking of pitch accents (accent is often called pitch accent because accent is associated with pitch prominence), Pierrehumbert (1980) uses seven different pitch accent types: H*, L*, H**L, H+L*, L**H, L+H*, and H**H, while the ToBI system (1994) reduces Pierrehumbert's rich inventory of pitch accents to five: H*, L*, L**H, L+H*, and H+!H*. According to their conventions, the diacritic, *, indicates that the tone is aligned with a stressed syllable, and the unstarred tone of a bitonal accent precedes or follows it at some given space in time. Thus, when some portion of an utterance is to be accented, it is associated with one of these pitch accent types.

KNDK, by contrast, has neither a rich inventory of pitch accents nor different alignments of the pitch accent with the accented syllable. A lexically linked single H tone and periphery tones (phrase accent or boundary tone) are the most straightforward constituent of an intonation contour, and the alignment between tones and text is very simple as shown in Cho (1994). Moreover, the accent locus is lexically contrastive, as in *carí* 'sack' and *cári* 'seat', and therefore must be specified in the lexicon. Since accentually prominent syllables are associated with a lexically linked H tone, we can treat the accent as a lexically linked H tone, following Pulleyblank (1983), Poser (1984), and Beckman and Pierrehumbert (1986). Therefore, KNDK does not have to rely on the notion of the star to represent the alignment of the pitch accent with the accented syllable because the pitch accent always aligns with the H toned syllable.

However, when several accentual phrases exist in an utterance, the pitch value of an accented syllable in each phrase may not be the same (the pitch value of an accented syllable in an utterance may vary as peak values of each word in a list vary (Cho 1996, 1997)). There should therefore be a way to represent the relative pitch prominence among accentual phrases. If we take a given sentence, such as (2), for example, there are three accentual phrases as shown in Figure 2d. The first phrase has the nuclear accent (the most prominent accent) in the utterance and the subsequent phrases show a gradual decrease in pitch values. If we were to mark the accented syllables in each phrase with a high tone alone, the phonological representation shown in (4a) would not be able to account for relative pitch prominence across phrases. In order to provide appropriate phonological representation for the F_0 contours given in Figure 2d, we can use the diacritic, *, as shown in (4b), to represent a nuclear accent in an utterance, but not the alignment between a pitch accent and a high toned syllable.

Although the star notation represents the nuclear pitch accent in an utterance, the representation in (4b) still leaves unexplained the relation between the first phrase and the remaining two phrases. In order to represent any downstepped H tones (H tones whose pitch levels are lower than the pitch of the preceding H tone) subsequent to a nuclear accent, we can use a diacritic, !, in front of a downstepped pitch accent as shown in (4c). The use of the diacritic, !, eliminates Pierrehumbert's H^*+L notation (1980), shown in (4d), as a necessary downstep trigger.

(4)	omma-ga	manəl-əl	mutta.
a.	H	L- H	L- H L%
b.	H*	L- H	L- H L%
c.	H*	L- !H	L- !H L%
d.	H*+L	H*+L	H*+L L-L%

In sum, the F_0 contours of (4) as shown in Figure 2d can be represented in three parallel tiers - an orthographic tier, a tone tier, and a break index tier, as in (4c').

(4c')	omma-ga	manəl-əl	mutta.	→ An orthographic tier
	H*	L- !H	L- !H L%	→ A tone tier
		3	3 4	→ A break index tier

The representation as in (4a) shows clear advantages over Pierrehumbert's notation (1980) shown in (4d) because it can represent clear phrase boundaries and the relation of pitch prominences among accentual phrases with the help of break indices and diacritics such as ! (downstepped pitch accent), - (phrase accent, or accentual phrase boundary marker), and * (nuclear pitch accent).

4. Focus & Its Representation

This section applies the proposed annotation conventions to utterances which have the same string of words with the same syntactic structure but have different intonation contours distinguished by the position of the intonational nucleus affected by the focus of an utterance.

4.1 Ordinary Focus

Jackendoff (1972) defines '*focus*' of a sentence as the information in the sentence that is assumed by the speaker not to be shared by him and the hearer. Thus, a focal part of an utterance contains what the speaker is presenting to the listener as *new* and the focal part is associated with pitch prominence. The remaining part of utterance contains *given* information which is shared by him and the hearer, and this part does not have prominent pitch values. Oehrle (1991) illustrates the relation between new and given information in question-answer pairs of English. This is also possible in KNDK, as shown in (5) to (7). Here underlining is used to indicate the pitch prominence on the focal part.

(5) Q: mǎ-ga kegi mut-no?
 what-Nom. meat ate-Int.
 "What ate the meat?"

A: koyaŋi-ga gegi-rǎl mutta.
 cat-Nom. meat-Acc. ate
 "The cat ate the meat"

(6) Q: koyaŋi-ga mǎ mut-no?
 cat-Nom. what ate-Int
 "What did the cat eat?"

A: koyaŋi-ga kegi-rǎl mutta.

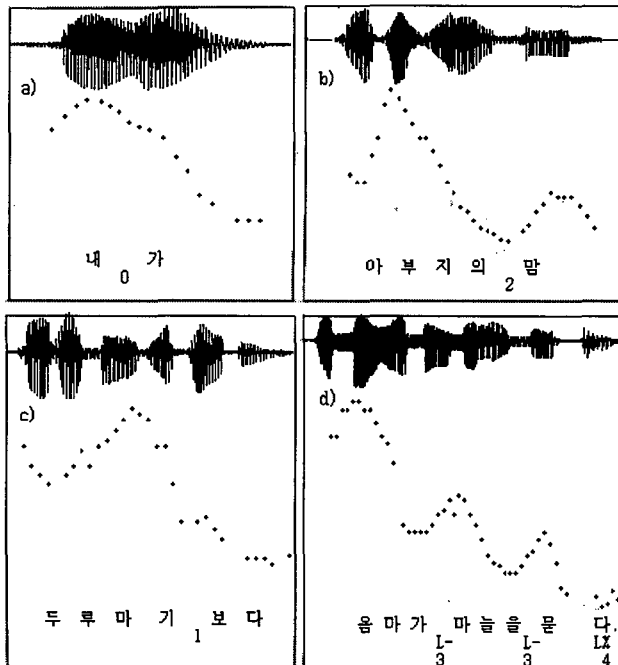
(7) Q: koyaŋi-ga kegi uc'et-no?
 cat-Nom. meat what did-Int

"What did the cat do with the meat?"

A: koyaŋi-ga gegi-rǎl mutta.

In (5) the given information is that something ate the meat, and *koyaji* 'cat' is the focus, the new information being conveyed. Accordingly, the focal phrase, *koyaji-ga*, has the most prominent pitch accent as shown in Figure 2a, and the remaining phrases show a gradual decrease in pitch values. Though there are three accentual phrases, it is possible to have just one accentual phrase in fast speech, with only the focal phrase bearing the pitch accent. Then, the remaining phrases fill in the space between the nuclear pitch accent and the intonational boundary tone, and their boundaries are marked by the break index 1 as shown in Figure 2b. In (6), the given information is that the cat ate something. *kegi* 'meat' is the focus in this answer and bears the most prominent pitch accent as shown in Figure 2c. Though the first phrase and the focal phrase are demarcated by a phrase tone in this contour, it is also possible to have an intonational boundary tone (L%), depending on the speech pattern.

Figure 2. a) shows F_0 contours for an answer in (5), and b) shows another pitch contour for the answer in (5). There is only one accentual phrase. This pattern is possible in fast speech. c) shows F_0 contours for an answer in (6), and d) shows F_0 contours for an answer in (7).



That is, it is often observable that speakers put a strong pause between the first phrase and the focal phrase. In (7) the given information is that the cat did something to the meat, and the new information is *mutta* 'ate' which bears the most prominent pitch as shown in Figure 2d.

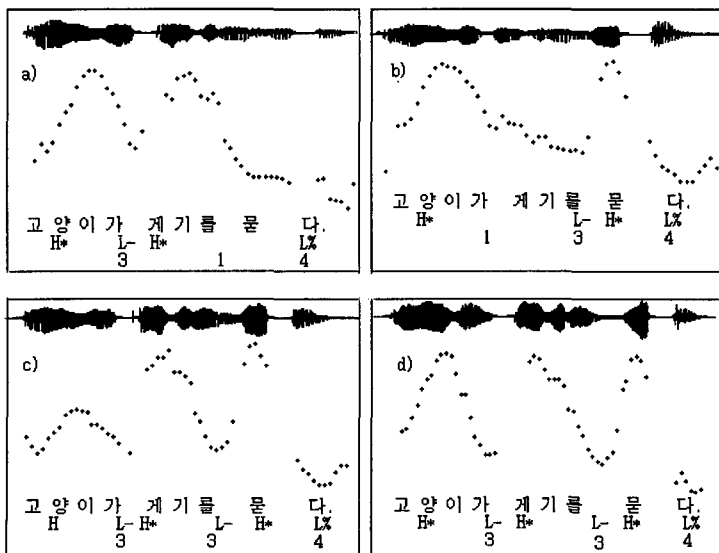
In each question-answer pair, the particular prosodic contour of the same text in each answer can be used exclusively for a particular question type. If the F₀ contours in Figure 2c, for example, were used as an answer to the question in (5), it would not be a felicitous answer, though the sentence is grammatical.

4.2 Multiple Foci

Though only one focal part has been shown in 4.1, it is possible to have more than one focal part in an utterance. The multiple foci can be easily seen in the following question-answer pairs.

- (8) Q: *mə-ga mə mut-no?*
 What-Nom. what ate-Int.
 "What ate what?"
 A: *koyaŋi-ga kegi-rəl mutta.*
 cat-Nom. meat-Acc. eat
- (9) Q: *kegi uc'e-det-no?*
 meat what-happened-Int.
 "What happened to the meat?"
 A: *koyaŋi-ga kegi-rəl mutta.*
- (10) Q: *koyaŋi-ga məl uc'et-no?*
 cat-Nom what did-Int.
 "What did the cat do?"
 A: *koyaŋi-ga kegi-rəl mutta.*
- (11) Q: *uc'e-det-no?*
 what-happened
 "What happened?"
 A: *koyaŋi-ga kegi-rəl mutta.*

Figure 3 a), b), c), and d) are F₀ contours and their prosodic representations for answers in (8), (9), (10), and (11), respectively.



In (8) the given information is that something ate something, and *koyaji* 'cat and *kegi* 'meat' are the new information being conveyed. These focal parts are marked by the pitch accent, H*, representing the most prominent pitch in the answer as shown in Figure 4a, and the boundary between these two focal phrases is marked by an F₀ dip and represented by a phrasal accent, L-. In (9) the given information is that something happened to the meat. *koyaji* and *mutta* 'ate' bear the focus in the answer, and they also bear the most prominent pitch accent as shown in Figure 3b. Though the first phrase and the second phrase in this answer form one accentual phrase and the boundary between the two phrases does not have a tonal indication, it is possible to have a clear phrase boundary between the two phrases, depending on the speech pattern. If this happens, the boundary between the two phrases will be marked by a low phrase accent (L-) and the second noun phrase will bear a downstepped H tone (!H). In (10) the given information is that the cat did something to something, and the new information is shown in the verb phrase, *kegi-rəl mutta* 'ate the meat'. The object and the verb in this verb phrase bear the focus in the answer, and both are represented by H* accents as shown in figure 3c. In (11), there is no given information. The answer as a whole is the new information, and every accentual phrase contains a pitch accent, H*, and its boundary is marked by a low phrase accent (L-) as shown in figure 3d.

In these question-answer pairs, the phrase boundary between the adjacent accented phrases is clearly marked by an F₀ dip. Instead of the unaccented syllables maintaining high F₀, resulting in a plateau contour due to H tone spreading, the high F₀ is not sustained on unaccented syllables between the two H* accents. This fact suphat an accentual phrase can have only one pitch ports the claim accent. As in each question-answer pair shown in section 4.1, the particular prosodic contour of the same text in each answer can be used exclusively for a particular question type. For example, the F₀ contours in figure 3c can be used as an answer exclusively for the question in (10). If the answer in (10) were used as an answer to the question in (9), it would not be a felicitous answer.

In sum, the F₀ contours of the same sentence can change according to different locus of the focus. However, the surface syntactic structure does not determine the locus of the intonational nucleus (the most prominent pitch accent in an utterance) from the set of the components that can be focused. Only different prosodic representation can represent the relation between the focused part and the unfocused parts (the relation between the new information and the given information).

5. Conclusion

This paper focused on the prosodic representation system, based on the ToBI system, of different intonation contours affected by the position of the intonational nucleus which in turn is affected by the focus of an utterance. Although KNDK does not need all the pitch accents which ToBI uses for the transcription of English intonation patterns, the proposed system can clearly represent the locus of the intonational nucleus, the relative pitch prominence among accented phrases, and different categories of boundaries in the three tiers.

Although this paper is limited to the prosodic transcription of different intonation contours affected by different focus loci, it is anticipated that establishing large corpora for spoken language and developing a comprehensive prosodic representation system which can cover the most important prosodic phenomena in Korean will enable the system to contribute not only to a more detailed theory connecting prosody, syntax, and intonation, but also to current text-to-speech synthesis approaches, speech recognition, and other quantitative computational modellings.

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