
Korean Intonational Phonology and Prosodic Transcription

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8.1. INTRODUCTION

This chapter presents an overview of Korean intonational structure and the most updated version of K-ToBI (Korean Tones and Break Indices) transcription conventions. Korean in this paper refers to Seoul Korean, the standard dialect of Korean. Korean differs from other languages described in this book in that it has neither lexical pitch accent nor lexical stress. Some dialects of Korean such as the Kyungsang dialect have lexical pitch accent as in Tokyo Japanese, but most other dialects including Seoul Korean do not.

Though researchers agree that Seoul Korean does not have lexical stress, it is controversial whether Korean has fixed stress at the word level or phrasal stress. Some believe that Korean has word level stress and that it is sensitive to syllable weight (H.-B. Lee 1964, 1974; H.-Y. Lee 1990; see Lim 2001 for a review); i.e., a word-initial heavy syllable is stressed, and if the first syllable is not heavy, the second syllable is stressed. Thus, according to this view, stress falls on the initial, i.e., first or second, syllable of a word regardless of the word length. Here, ‘heavy’ is defined as a closed (CVC) or long syllable and is claimed to be acoustically realized with a longer duration.

However, production and perception studies of stress in Korean (Jun 1995*a*; Lim 2001) suggest that the perception of stress on the word-initial syllable is due to the intonation pattern of Korean. Jun (1995*a*) showed that the so-called ‘stressed’ syllables are always realized with the fundamental frequency (f_0) peak when the word is uttered in isolation. When the same word was uttered in utterance-medial position, the ‘stressed’ syllable of the word showed high f_0 only when the word was placed at Accentual Phrase-initial position (see Section 8.2.2 for the definition of an Accentual Phrase). The perception test reported in Jun (1995*a*) showed that subjects (seventeen English, two Chinese, one French, one Italian, and one Japanese) perceived

the Accentual Phrase (AP) ‘initial’ syllable as stressed, i.e., prominent. When a word-initial ‘stressed’ syllable was located in the AP-medial position, the syllable was not produced with high *f₀*, and it was not perceived as prominent. That is, subjects perceived a word-initial syllable as prominent only when the syllable was AP-initial. In addition to the AP-initial syllable, an AP-final syllable was sometimes perceived as prominent.¹ This confirmed the perception of prominence based on high *f₀* because, in Seoul Korean, AP-initial and AP-final syllables are often produced with high *f₀* (see Section 8.2.2 for the phonetic realization of an AP).

Lim (2001) and Lim and de Jong (1999) further illustrate why the perception of prominence or stress has been claimed to be sensitive to syllable weight. They measured the timing of the phrase-initial *f₀* peak when the phrase begins with a heavy or light syllable and found that in general the peak is realized at the end of the first syllable when the syllable is heavy but that it is on the second syllable when the initial syllable is light. This shows that the realization of the *f₀* peak is influenced by the segmental formation of a syllable.

Since these *f₀* peaks correlated with the so-called stressed syllables are due to the Korean intonation pattern, Jun (1995*a*) concluded that the prominence claimed to be a property of a word does not refer to a word level stress but is linked to a phrasal phenomenon, i.e., a by-product of a phrase level prosody.

These different views of stress in Korean have been reflected in the study of rhythm and intonation. The next section describes the intonation studies based on word level stress and phrase level stress. Stress, though hard to define acoustically, was used to define a rhythmic unit in Korean (called ‘maltomak’ in H.-B. Lee (1964, 1974)), and the view of phrasal level prominence was taken in the intonation phonology of Korean and the transcription of Korean prosody (Jun 1996, 2000) by analysing the phrase-initial *f₀* rise as a phrasal tone, instead of a pitch accent as in English.

The organization of this chapter is as follows. Section 8.2 describes the previous research and intonational phonology of Seoul Korean; Section 8.3 describes the transcription conventions of Korean ToBI (Jun 2000), and Section 8.4 reports the results of labeller agreement and consistency in the transcription of Korean prosody using Korean ToBI.

¹ This supports the observation of Polivanov (1936) and Trubetzkoy (1939) that Korean tends to emphasize a word final syllable, demarcating a word boundary (cited in Koo 1986). This is so because an AP-final syllable coincides with a word-final syllable, and in general one word forms one AP unless the accentual phrasing is influenced by focus, semantic relation, and speech rate, in which case more than one word can form one AP (see Jun 1993, chapter 5 for factors affecting the phrasing; Schafer and Jun 2002 for default phrasing).

8.2. INTONATION OF SEOUL KOREAN

8.2.1. *Background*

Korean is an intonation language. The pitch modulation over an utterance is not specific to a certain syllable of a word, but is a property of a sentence. The intonational contour of a sentence changes the sentence type and the meaning or the information structure of a sentence. For example, a sentence can be interpreted as a declarative if it ends in a Low tone but as an interrogative if ending in a High tone. In addition, the same sentence can be interpreted as a yes-no question or a wh-question depending on the intonational phrasing of the sentence (Jun and Oh 1996). Unlike English or German where *fo* peaks and valleys, e.g. pitch accents, are in general linked to the stressed syllable of a word, the peaks and valleys of Korean intonation do not link to any specific syllable of a word but to a certain location of a phrase.

Early studies of Korean intonation (e.g. Martin 1954; H.-B. Lee 1964, 1974; S.-B. Cho 1967) focused on the tonal contour occurring at the end of an utterance, influenced by the tradition of British intonation models. Relying exclusively on auditory impressions, they proposed multiple tonal categories. Martin (1954) proposed seven intonation morphs such as Period intonation, Comma intonation, and Question-mark intonation, etc., while H.-B. Lee (1964) proposed three static (perceptually level pitch) tones and seventeen kinetic (gliding pitch) tones (nine uni-directional tones, four bi-directional tones, and four tri-directional tones). On the other hand, S.-B. Cho (1967) proposed twelve directional intonational forms (four uni-directional, four bi-directional, and four tri-directional forms) with three levels of voice range.

Among these, H.-B. Lee (1964, 1974) was also concerned with a rhythmic unit within an utterance. He proposed ‘maltomak’ (a rhythmic unit, literally meaning ‘a unit of speech’) which includes one stressed syllable, optionally preceded and followed by one or more unstressed syllables. This unit can be larger than a word or smaller than a word and is influenced by speech rate and speech style. It is preceded and followed by a pause, large or small. H.-Y. Lee (1990) extended H.-B. Lee’s (1974) model by proposing a Rhythmic Group, a rhythmic unit higher than the maltomak. His Rhythmic Group corresponds to an intonation group as well as a breath group; thus, it could be larger than Jun’s Intonation Phrase (see Section 8.2.2). However, like H.-B. Lee (1974), H.-Y. Lee’s analysis of Korean intonation, which is also based on the impressionistic descriptions adopting the British intonation model (i.e., O’Connor and Arnold 1973), does not provide objective criteria

of each prosodic unit. As noted in Seong (1995), the rhythmic unit, *maltomak*, does not have clear phonetic cues, and some of the domains could only be perceived by a trained phonetician. The abstract nature of *maltomak* in these studies is partly due to the ambiguous nature of stress in Korean (see Section 8.1) and also partly due to the subjective criteria based on the author's auditory impression in defining the unit.

Koo (1986) is, to my knowledge, the first acoustic study of intonational structure of Korean based on pitch track analysis. He identifies five different patterns from monosyllabic utterances: (1) rise, (2) rise-fall-rise, (3) rise-fall, (4) level, and (5) fall; and three terminal tonal variations from various sentences: (1) rise-fall, (2) large rise-large fall, and (3) rise. Koo also identifies a basic tonal pattern of a small phrase within an utterance, called a 'minor phrase'. His minor phrase is marked by a phrase final rising; thus, it seems to correspond to the Accentual Phrase in Jun's (1993, 1998) model described below.

These earlier studies of Korean intonation, however, described intonation phonetically. They did not assume that *f₀* contours are composed of a sequence of categorically distinct tones which defines a hierarchical prosodic structure at a phonological level. They also did not distinguish intonation, i.e., *linguistic* features of *f₀*, from paralinguistic features of speech (see Ladd 1996, chapter 1, for the definition of intonational phonology). They proposed certain tonal categories based on a speaker's emotional state and his or her attitude towards a hearer. Except for Koo (1986), their analyses were based on auditory impressions and did not have objective criteria of defining an intonational or rhythmic unit.

8.2.2. *Intonational phonology of Korean*

A phonological model of Korean Intonation was proposed by Jun (1993, 1998), based on previous work by de Jong (1989), S.-H. Lee (1989), and Jun (1990). According to this model, which adopts the autosegmental-metrical model of intonation developed by Pierrehumbert and her colleagues (Pierrehumbert 1980; Beckman and Pierrehumbert 1986; Pierrehumbert and Beckman 1988; see Ladd 1996 for extensive review), the intonational structure of Korean is hierarchically organized in such a way that an Intonation Phrase (= IP) can have more than one Accentual Phrase (= AP), which in turn can have more than one phonological word (= w; a lexical item followed by case markers or postpositions). The AP in Korean is, thus, similar to the Accentual Phrase in Tokyo Japanese (Pierrehumbert and Beckman 1988; Venditti 1995, this volume Ch. 7) or the Accentual Phrase in French (Jun and Fougeron

1995, 1997, 2000, 2002; Fougeron and Jun 1998). It is a tonally demarcated unit which can contain more than one lexical item.

Existing data on intonational phrasing (e.g. Jun 1989, 1990, 1993) suggest that the prosodic units in Korean are hierarchically organized following the Strict Layer Hypothesis (Selkirk 1984; Nespor and Vogel 1986; Hayes 1989). That is, an IP is exhaustively parsed into a sequence of APs, and an IP boundary coincides with an AP boundary which again coincides with a word boundary. The intonational structure of Seoul Korean is schematically represented in Figure 8.1. Categories in the parentheses are optional.

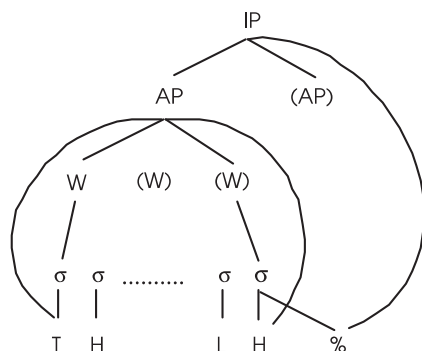


FIGURE 8.1 Intonational structure of Seoul Korean.

IP: Intonation Phrase AP: Accentual Phrase
 w: phonological word σ: syllable
 T = H, when the syllable-initial segment is aspirated/tense; otherwise, T = L
 %: Intonation Phrase boundary tone

The IP and the AP are two prosodic units in Korean marked by intonation. An IP contour includes tonal patterns of one or more APs and an IP boundary tone. An IP-final syllable is substantially lengthened—about 1.8 times longer than a non-IP-final syllable (Korea Telecom Research and Development Group Report 1996) and optionally followed by pause. An AP has a tonal pattern demarcating the beginning and the end of the phrase. When an AP is final to an IP, the IP-final syllable is realized with the IP boundary tone by preempting the AP-final tone. The first segment of the AP is slightly, and consistently, longer than the same segment in the AP medial position (Jun 1993, 1995*b*; T. Cho and Keating 2001; Keating *et al.* 2004), but the AP final segment is not always longer than the AP medial segment (Koo 1986; Jun 1993, 1995*b*, 1996; T. Cho and Keating 2001). Furthermore, an AP is never followed by a pause unless it is the last phrase of an IP.

A phonological word (= w) has no tonal pattern specific to this level, but it has been shown that, like an AP and an IP, a phonological word in Korean serves as the domain of phonetic strengthening and weakening: VOT (Voice Onset Time) is longer and the linguopalatal contact area of stops is larger at the beginning of each prosodic unit (w, AP, IP) than in the middle of each unit, and VOT is longer at the beginning of a higher prosodic unit than at the beginning of a lower prosodic unit (Jun 1993; T. Cho and Keating 2001; Keating *et al.* 2004).

Finally, like the prosodic units in Greek (Arvaniti and Baltazani this volume Ch. 4), Korean prosodic units defined by intonation are also domains of segmental phonological rules (Jun 1993, 1998). For example, an AP in Korean is the domain of Lenis Obstruent Tensing: a lenis obstruent becomes tense after a lenis obstruent if both are in the same AP but not if there is an AP boundary between the two lenis obstruents. An IP also serves as the domain of phonological rules such as Obstruent Nasalization and Spirantization (Jun 1993).

(i) *The accentual phrase*: the most common tonal pattern of the AP is Low-High-Low-High (LHLH) or High-High-Low-High (HHLH), thus, THLH in Figure 8.1 with T = H or L. The AP-initial tone is determined by the laryngeal feature of the phrase-initial segment: when the segment is either aspirated or tense, having [+stiff vocal cords] (Halle and Stevens 1971), the AP begins with a H tone; otherwise, with an L tone. (For quantitative data about this tonal difference, see Jun 1996; H.-J. Lee and Kim 1997; H.-J. Lee 1997.) When an AP has more than three syllables, the two initial tones of an AP are associated with the two initial syllables of the AP, and the two final tones of an AP are associated with the two final syllables of the AP. The syllables between the second and the penult of the AP, if there are any, get their surface pitch values by interpolating between the H tone on the second syllable and the L tone on the penult. The slope of this falling fo is negatively correlated with the number of syllables within an AP (J.-J. Kim *et al.* 1997). This suggests that the two rises in sequence, AP-initial rise and AP-final rise, are not independent, but belong to the same tonal unit.

The second AP tone, H, is in general realized on the second syllable of an AP (Koo 1986; S.-H. Lee 1989; Jun 1990), but as reported in H.-J. Lee and H.-S. Kim (1997), for speakers who tend to undershoot the penult L tone, the H is sometimes (27–40 per cent) realized on the third syllable in a five-syllable-AP. More recently, however, de Jong (2000) found that the H tends to be realized at the end of the first syllable of an AP when the syllable is a closed syllable. Thus, in this paper, I will adopt Jun's (1993) claim that the second AP tone H is *loosely* associated with the second syllable of an AP.

When an AP has fewer than four syllables, it does not show two rising patterns. Instead, when an AP begins with a non-aspirated/tense segment, it

shows a simple rising pattern (LH) or a delayed rising pattern (LLH) or an early rising pattern (LHH) (or for an AP beginning with an aspirated/tense segments, HH, HLH, and HHH patterns, respectively). Thus, it is assumed in Jun (1993, 1998) that the underlying tone pattern of an AP is THLH and one or both of the two middle tones (i.e., THLH) are undershot when there is not enough time to reach the tonal target. But it is not clear what the conditions for undershooting one of the two middle tones are (e.g. LHH vs. LLH). Observation of data shows that the choice of tones undershot varies across speakers and across different discourse contexts (H.-J. Lee and H.-S. Kim 1997). More importantly, different tonal realizations do not seem to have contrastive meaning.

In addition, the final tone of an AP is sometimes realized as an L tone due to a constraint on the tonal sequence or stylistic variations. This happens whether an AP is long or short. This means that there are at least fourteen surface tonal patterns for an AP (see Figure 8.6 for schematic *fo* contours of the AP tonal patterns).

(ii) *The intonation phrase*: an IP boundary tone is realized on the IP-final syllable, indicating the pragmatic meaning of the phrase as well as information about the sentence type (Park 2003). Depending on the shape of *fo* contour starting from the onset of the IP-final syllable, at least nine boundary tones have been identified (L%, H%, LH%, HL%, LHL%, HLH%, HLHL%, LHLH%, LHLHL%). H% and LH% differ in the timing of rising (see Figures 8.8, 8.9, 8.10); LH% rises later than H%, showing a *fo* valley at the beginning of the IP-final syllable. The same is true with HL% vs. LHL% and HLH% vs. LHLH%. In general, tones ending with H% often have the function of seeking information (e.g. question) and those ending with L% often have the function of making a statement. However, the relationship between a tone and the meaning is many-to-many. That is, more than one boundary tone can be used to mark the same meaning, and the same boundary tone can be used for more than one meaning (e.g. H.-Y. Lee 1997; Park 2003). For example, a *wh*-question can be marked by L%, H%, LH%, HL%, or HLH% (see Jun and Oh 1996), but each boundary tone can also mark different sentence types or pragmatic meanings. Furthermore, boundary tones delivering the same pragmatic meaning or marking the same sentence type can be different depending on sentence endings. Park (2003) reports that the sentence ending in <-guna> takes HL% while <-ne> takes LH% even though both of these deliver the same meaning of discovery and confirmation (e.g. <zaR bwaD-guna> vs. <zaR bwaD-ne> ‘You did a good job!’). More research is needed to identify a distinctive pragmatic meaning for each boundary tone and sentence ending.

8.3. KOREAN-ToBI (K-ToBI)

K-ToBI is a prosodic transcription convention for standard (Seoul) Korean. Like the other ToBI systems, K-ToBI assumes intonational phonology with a close relationship to a hierarchical model of prosodic constituents. The intonational analysis and attendant prosodic model of Seoul Korean adopted for K-ToBI are based on Jun (1993, 1996, 1998). A first version of K-ToBI was developed at ATR Interpreting Telecommunication Systems in Japan in late 1994 by Mary Beckman and Sun-Ah Jun, as part of a Korean synthesis development project. The second version (Beckman and Jun 1996) was proposed at the Prosody Transcription Workshop held just before ICPhS (International Congress on Phonetic Sciences) in Stockholm, August 1995. The current version is a revision of the second version by the author after the Korean ToBI Workshop in Korea, August 1998, and was presented at the workshop 'Intonation: Models and ToBI Labelling', a satellite meeting of ICPhS in San Francisco in August 1999.

The earlier versions of Korean ToBI had four parallel tiers as in the original ToBI system (i.e., Mainstream American English ToBI): words, tones, break-indices, and miscellaneous. But, in order to describe surface tonal patterns which are not always the same as the underlying tonal patterns, and not predictable from the underlying tones, the current version of K-ToBI expands the tones tier into two tiers, a phonological tone tier and a phonetic tone tier. (See the next section for motivation for this change.) Therefore, a K-ToBI transcription for an utterance now minimally consists of a recording of the speech, an associated record of the fundamental frequency contour, and the transcription-proper symbolic labels for events on five parallel tiers (a word tier, a phonological tone tier, a phonetic tone tier, a break-index tier, and a miscellaneous tier).

8.3.1. *Motivation of revision*

In the earlier version of K-ToBI, there were only two tones transcribing the tonal pattern of an AP, i.e. H- and LH_a. The H- was labelled to cover any high peaks occurring at the 'initial' (the first or second, and rarely the third) syllables of an AP, and the LH_a was labelled to mark the AP boundary ('a' for an AP boundary), which was typically realized as a rising pitch. This transcription, however, turned out to be too abstract and at the same time not distinctive enough.

Labelling LHa at the end of an AP was too abstract when an AP ended in an infrequent low pitch, or when the AP final two syllables do not show a rising pitch (i.e., LHH pattern). On the other hand, H- tone was not distinctive enough. The ToBI labelling system assumes that tones are labelled only when they are distinctive (Beckman and Ayers 1994; Beckman and Hirschberg 1994). However, the realization of AP initial peak is optional, constrained by the length of a phrase and the laryngeal feature of the AP initial segment, and its presence or absence does not seem to change the meaning of the utterance. What is distinctive is the presence or absence of an AP boundary. For example, *wh*-questions and *yes/no*-questions are distinguished only by an AP boundary between the *wh*-word and the following verb phrase (Jun and Oh 1996) and syntactically ambiguous sentences are disambiguated by differences in AP boundary locations (Schafer and Jun 2002). Thus, changing accentual phrasing can change the meaning of a sentence, but whether the AP is realized with initial rise or not does not seem to change the meaning of a sentence.

Furthermore, H-, being labelled at the first occurrence of a high-pitched syllable in an AP did not reflect the different phonetic realization of the peak depending on the origin of the H tone or the alignment of the peak to syllables. The AP initial peak is realized on the first syllable when the syllable begins with an aspirated or tense consonant. In this case, the following syllable is also realized with H tone. The AP initial peak can also be realized later than the first syllable when the first syllable does not begin with an aspirated or tense consonant and when the AP is longer than three syllables. Quantitative data show that *f₀* is significantly higher for the H tone on the first syllable of an AP (i.e., HHLH) than the H tone after AP-initial L tone (i.e., LHLH). (See Figures 8.2 and 8.4 to compare the *f₀* difference between these two H tones.) In addition, this extra-high *f₀* value in the beginning of the HHLH pattern influences the following syllables, if there are any, by raising the *f₀* values of these syllables, compared to those in the LHLH pattern, up to the penultimate syllable of an AP (see H.-J. Lee 1999 for more detail). This suggests that the AP initial peak should be labelled separately for the first and the second syllables, and that these two H tones should be treated differently from the distinctive tones marking the AP boundary.

Therefore, in the current version, we will split the tone tier and label the AP boundaries at a phonological tone tier, and the realization of AP tones at a phonetic tone tier aligned with the corresponding surface *f₀* event. Labelling the surface tones at a phonetic tone tier would also allow us to transcribe the fourteen different surface tonal patterns of AP including the AP final low tone and early rise and late rise (i.e., LH, LHH, LLH, LHLH, HH, HLH, HHLH,

LL, HL, LHL, HHL, HLL, LHLL, HHLL). These surface tonal patterns, though seemingly not distinctive, are not fully predictable, and the detailed conditions on the surface patterns or their pragmatic meanings are not yet known. By labelling surface tonal events on a phonetic tone tier, we hope to get answers to these issues and get information about the timing and magnitude of the *fo* realization of the surface tones.

It should be noted that labelling in the phonetic tone tier should not be interpreted as labelling the gradient phonetic detail of *fo* contour as in the narrow phonetic transcription such as INTSINT (Hirst and Di Cristo 1998; see Chs. 1 and 2 this volume for the distinction). The tonal inventories in the phonetic tone tier are categorical (i.e., H and L) and their distributions are limited, constrained by the alignment of the AP initial and final two syllables. The data from the phonetic tone tier will provide valuable information of phonetic implementations to researchers working on speech synthesis and recognition and provide feedback about the model to those working on a phonological model of Korean intonation.

Finally, by separating the tone tier into phonological and phonetic tone tiers, we can easily accommodate tonal transcriptions of other dialects. For example, the tonal pattern of an AP in the Chonnam dialect (a southwestern dialect of Korean) is the same as that of the Seoul dialect except that its AP final is falling (i.e., LHL or HHL; Jun, 1989, 1993, 1996, 1998). Though the tonal patterns of APs differ between the two dialects, the accentual phrasing is the same for these dialects. Thus, the boundaries marked on the phonological tone tier of Seoul Korean will remain the same for the Chonnam dialect, while the phonetic tone tier of these two dialects will differ, conforming to the surface realization of each dialect. I assume this will be true for other dialects of Korean which do not have lexical pitch accent.

In the following sections, each of the five tiers is defined, and the labels and symbols proper for each tier are introduced. In addition, example sentences illustrate how to label information on each tier aligned with pitch tracks using *PitchWorks* (Scicon R&D), speech analysis and labelling software similar to *xwaves*. A summary of tones and break indices is given in Appendix A.

8.3.2. *Tiers*

(i) *The words tier*: the words tier in K-ToBI corresponds to the ‘orthographic tier’ in English ToBI. In this tier, words may be labelled using either Hangul orthography or some conventional Romanization. In the current K-ToBI, words are transcribed following the Romanization convention shown in Appendix B. What constitutes a ‘word’ in Korean is controversial. In this

version, we consider it as a sequence of segments divided by a space in a written Hangul text. The word label should be placed at the end of the final segment in the word, as determined by the waveform or spectrogram record. Filled pauses and the like should also be labelled on this tier.

(ii) *The phonological tone tier*: the phonological tone tier includes the boundary tone of an AP and an IP. Since an AP boundary tone in an IP-final position is overridden by the IP-final boundary tone, only the IP-final boundary tone (%) will be labelled at the end of an IP.

The boundary of an IP-medial AP will be labelled by ‘LHa’ reflecting the most common AP-final rising tone in Seoul Korean. An IP final boundary will be labelled by one of the nine different boundary tones: H%, L%, HL%, LH%, HLH%, LHL%, HLHL%, LHLH%, LHLHL%. Instructions on where to put phonological tone labels are given below. To simplify the description of IP boundary tones, ‘T’ is used below as a variable for the IP boundary tones. The meaning of each boundary tone and example sentences labelled with phonological tones are given in the next section.

- | | |
|-----|---|
| LHa | marks the end of an IP-medial AP, aligned with the end of the AP-final segment determined from the waveform. |
| T% | marks the end of an IP, aligned with the end of the IP-final segment determined from the waveform. ‘T’ can be H, L, HL, LH, HLH, LHL, HLHL, LHLH, or LHLHL. |

(iii) *The phonetic tone tier*: the phonetic tone tier includes the surface tone patterns of APs and IPs. For IP tones, there are nine boundary tones. For AP tones, there are three initial tones (i.e., L, H, and +H) and three final tones (i.e., La, Ha, and L+).

AP-initial tones:

- | | |
|----|--|
| L | This tone marks an L tone on the first syllable of an AP. This label should be aligned with the fo valley on the first syllable of an AP. |
| H | This tone marks an H tone on the first syllable of an AP. This label should be aligned with the fo peak on the first syllable of an AP. |
| +H | This tone marks the H tone on the second syllable of an AP (or sometimes the third syllable when the AP is long, uttered quickly, or produced under focus). This label should be aligned with the fo peak around the second syllable. When the peak continues over the following syllable, align this label with the latest fo peak of the phrase-initial peak. This tone is not labelled if both the preceding and the following syllables have a H tone. |

Figure 8.2 shows an example pitch track illustrating how to label AP-initial tones on the phonological and phonetic tone tiers. The phonological tone tier is named ‘Utones’; the phonetic tone tier ‘Stones’; and the word tier ‘words’.

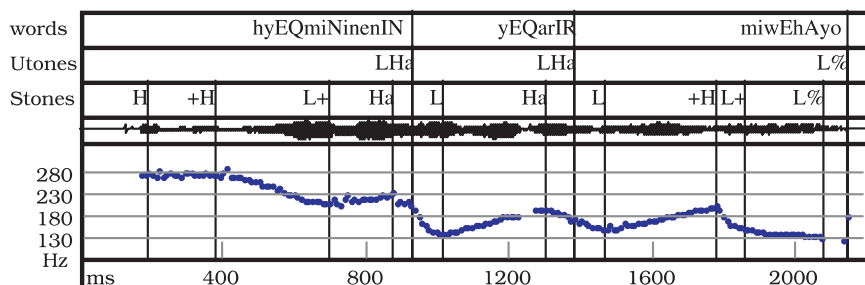


FIGURE 8.2 An example utterance, hyEQmiNinenIN ‘Hyungmin’s family-_{TOP}+ yEQarIR ‘Younga-_{ACC}+miwEhAyo ‘hate’ => ‘Hyungmin’s family hates Younga’, illustrating how to label AP-initial tones. The first AP begins with an H tone, and the second and the third APs begin with an L tone. +H is shown in the first and the last APs.

AP-final tones:

- Ha This tone marks either the end of a rising tone or a high flat tone. It is the most common AP-final tone. This label is aligned with an actual *f₀* peak on the AP-final syllable.
- La This tone marks either the end of a falling tone or a low flat tone. This AP-final tone is less common. This label is aligned with an actual *f₀* valley on the AP-final syllable.
- L+ This tone marks the low pitch on the penultimate syllable of an AP. This tone is not labelled if the low pitch on the penult is predictable from adjacent tone labels (e.g. when an AP is continuously falling from an initial H to a final La or when an AP-initial tone is L and the final tone is La). When not predictable, this label is aligned with an actual *f₀* valley on the penult of an AP. When there is a low plateau adjacent to the penult, place this label at the transition point, i.e., H to L or L to H (see Figure 8.4).

The ‘+’ sign in Korean ToBI, i.e., +H and L+, refers to a syllable boundary and implies a grouping of tones: +H is part of the AP-initial tone realized on the second syllable of an AP and L+ is part of the AP-final tone realized on the penult of an AP. This is different from the ‘+’ in English bitonal pitch

accents such as L+H* or L*+H, where both tones are associated with a stressed syllable with the unstarred tone being realized either before the starred tone (i.e., a leading L tone in L+H*), or after it (i.e., a trailing H tone in L*+H). Figure 8.3 shows an example of AP-final tones, Ha, La, L+. Figure 8.4 shows examples of L+ before an AP-final rise and an L+ before L%.

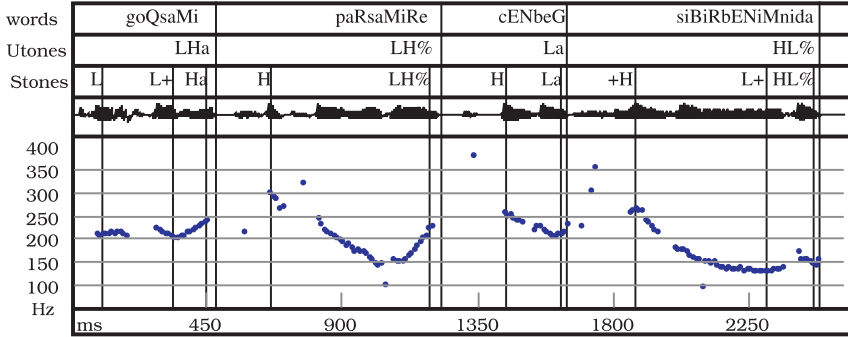


FIGURE 8.3 An example utterance, goQsaMi ‘032’+paRsaMiRe ‘831-and’+cENbeG siBiRbENiMnida ‘1111-number-is’ => ‘(The phone number is) 032-831-1111’, illustrating AP-final tones: Ha (1st AP), La (3rd AP), and L+ (1st and last AP).

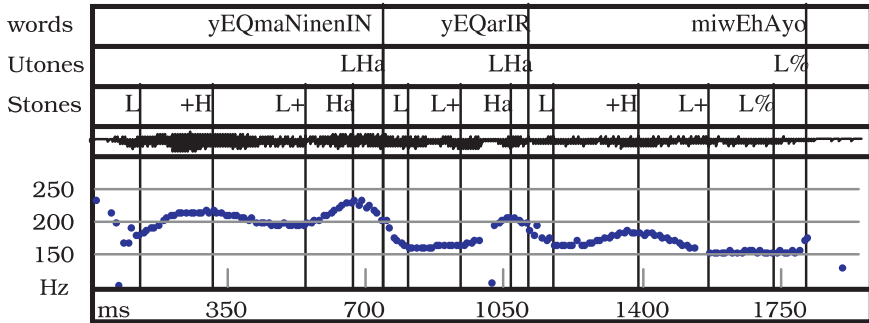


FIGURE 8.4 An example utterance, yEQmaNinenIN ‘Youngman’s family-TOP’+yEQarIR ‘Younga-ACC’+miwEhAyo ‘hate’ => ‘Youngman’s family hates Younga’, illustrating how to label an AP-final L+ tone.

When an AP has three tones, the mid tone can be either L (e.g. LLH) or H (e.g. LHH). In this case, we will consider the medial L as a part of the *final* AP tone and the medial H as a part of the *initial* AP tone because we believe that both are the undershoot version of the underlying two rises, LH-LH. That is, LLH is parsed as L-LH with the undershoot of the first H of LHLH, and LHH

is parsed as LH-H with the undershoot of the second L of LHLH. Therefore, LLH will be labelled as L, L+, and Ha, and LHH will be labelled as L, +H, and Ha, on each of the three syllables. Figure 8.4 shows an example of the ‘L L+ Ha’ surface tonal pattern, and Figure 8.5 shows example APs with two ‘L +H Ha’ patterns.

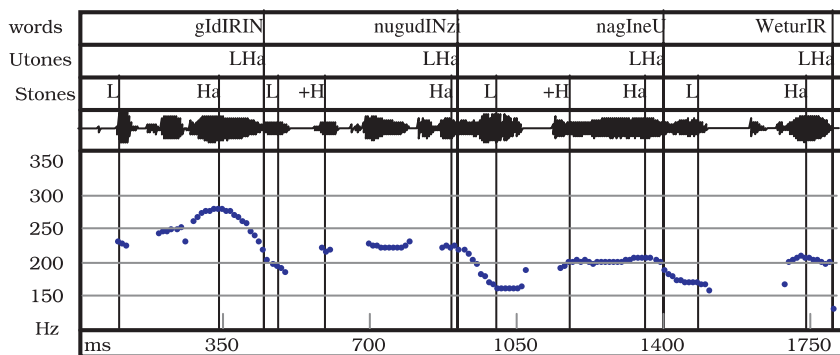


FIGURE 8.5 An example utterance, gIdIRIN ‘They-_{TOP}’+‘nugudINzi ‘whoever’+nagIneU ‘stranger-_{POSS.}’+WeturIR ‘clothes-_{ACC}’ => ‘They, whoever (takes off) the traveller’s clothes (first)’, illustrating APs with two ‘L+H Ha’ surface tone patterns (2nd and 3rd APs).

Schematic fo contours of fourteen types of AP realizations and corresponding phonetic tone labels are shown in Figure 8.6. The first row shows AP patterns with a high boundary, Ha, and the second row shows AP patterns with a low boundary, La. The third row shows contours of a long AP where all four underlying tones are realized with either a Ha or La boundary. ‘T’ in the last contour is either H or L.

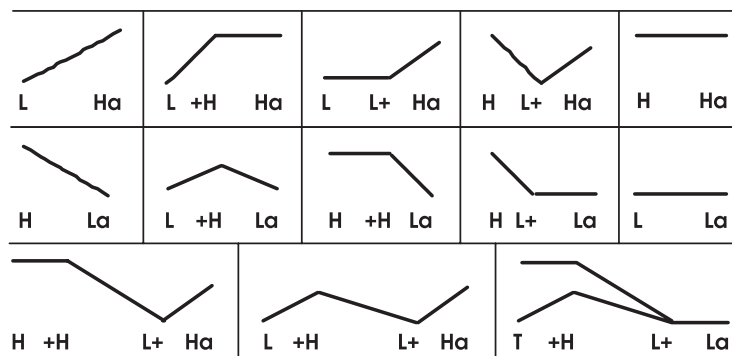


FIGURE 8.6 Schematic fo contours of fourteen tonal patterns of an AP, labelled in tones of the phonetic tone tier.

The following shows surface realization rules of each boundary tone and its location relative to words and fo contours.

IP-final boundary tones:

- | | |
|------|---|
| L% | A level ending or a gently falling boundary tone spread over much of the IP-final syllables. This tone is the most common in stating facts and in declaratives in reading. |
| H% | A rising boundary tone that begins to rise before the IP-final syllable and reaches its peak during the final syllable. Therefore, the rise is earlier than that in LH%. This tone is the most common in seeking information as in yes/no-questions. |
| LH% | A rising boundary tone that is more localized than H%, rising sharply from a valley well within the final syllable. That is, by comparison to H%, this is a sharper, later rise, starting after the onset of the final syllable. This is commonly used for questions, continuation rises, and explanatory endings. It is also used to signal annoyance, irritation, or disbelief (e.g. <gIrEHtaniKa gIrEne!> ‘I’ve already told you so. (Why do you keep asking me?)’ or <bEryESE!> ‘(Did you) throw it out? (I can’t believe that!)’). See Figure 8.7 (a) and (b) to compare H% and LH%. |
| HL% | A falling boundary tone that rises <i>before</i> the last syllable, and reaches its peak and then falls during the last syllable. Though it seems to be a combination of H% and L%, the H part of this boundary tone is not as high as a simple H% and the L is not as low as a simple L%. This tone is most common in declaratives and wh-questions. It is also commonly used in news broadcasting. |
| LHL% | A rising-falling boundary tone that, unlike HL%, rises <i>within</i> the IP-final syllable. The fo peak on H is not as high as that of LH%. It sometimes intensifies the meaning of HL%, but like LH%, it also delivers the meanings of being persuasive, insisting, and confirmative. It is also used to show annoyance or irritation (e.g. <hazima>! ‘Don’t do it (I told you before)’). See Figure 8.8 (a) and (b) to compare HL% and LHL%. |
| HLH% | A falling-rising boundary tone—a combination of HL% and H% in that the timing of the rise is the same as HL% but followed by a shallow dip and then another rise. |

- The location of the first H should be marked by ‘>’ above the fo peak. This tone is used when a speaker is confident and expecting listeners’ agreement. An example of HLH% is shown in Figures 8.9 and 8.13.
- LHLH% A rising-falling-rising boundary tone. The timing of the rise is like LH%. The location of the first H should be marked by ‘>’ above the fo peak. This tone is rare and has a meaning of intensifying some of the LH% meanings, i.e., annoyance, irritation, or disbelief.
- HLHL% A falling-rising-falling boundary tone. The timing of the rise is like HL%. The location of the two Hs should be marked by ‘>’ above the fo peaks. This tone is more common than LHLH% but not as common as less complex boundary tones. It sometimes intensifies the meaning of HL%, confirming and insisting on one’s opinion, and sometimes, like LHL%, it delivers nagging or persuading meanings.
- LHLHL% A rising-falling-rising-falling boundary tone. The timing of the rise is like LH% followed by LHL%. The location of the two Hs should be marked by ‘>’ above the fo peaks. This tone is rare, and its meaning is similar to that of LHL%, but has a more intense meaning of being annoyed.

Figures 8.7–8.9 show examples of IP boundary tones: H% and LH% in Figure 8.7, HL% and LHL% in Figure 8.8, and HLH% in Figure 8.9. In Figures 8.7 and 8.8, a vertical dashed line marks the beginning of the last syllable, ‘-yo’ [jo], showing the timing of the rise with reference to the final syllable.

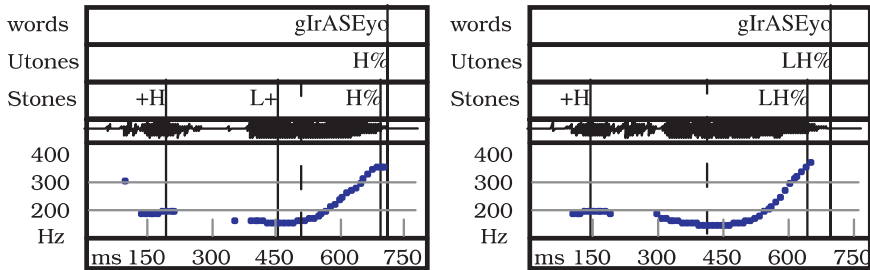


FIGURE 8.7 One-word utterance, grASEyo ‘Is that so?’, with (a) H% and (b) LH%.

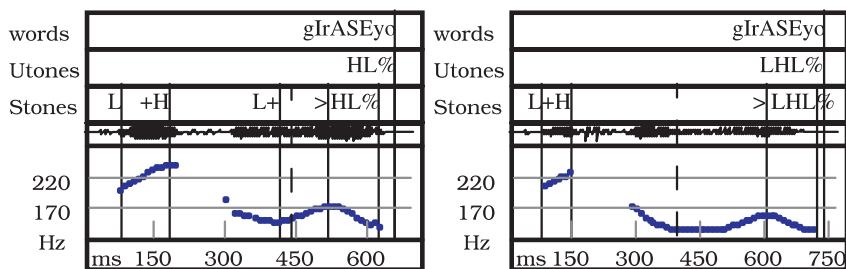


FIGURE 8.8 One-word utterance, gIrASEyo ‘Is that so?’, with (a) HL% and (b) LHL%.

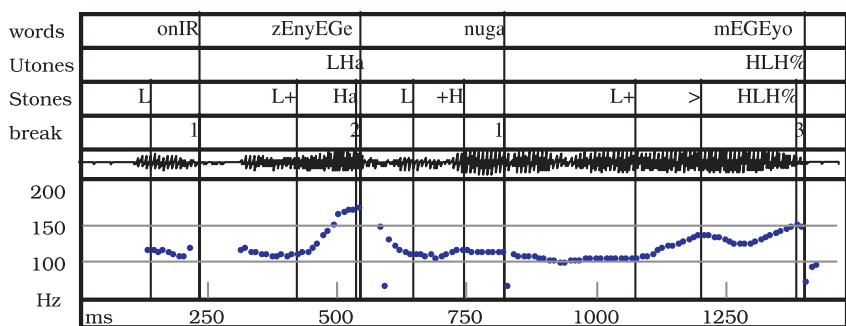


FIGURE 8.9 An example utterance, onIR ‘today’+zEnyEGe ‘night’+nuga ‘who’+mEGEyo ‘eat?’ => ‘Who is eating tonight?’, illustrating HLH%.

Schematic fo contours of eight types of IP boundary tone realizations are shown in Figure 8.10. The first row shows IP boundaries ending with L% and the second row shows those ending with H%. The vertical line shown in each contour marks the beginning of the IP-final syllable. The fo scale is not normalized.

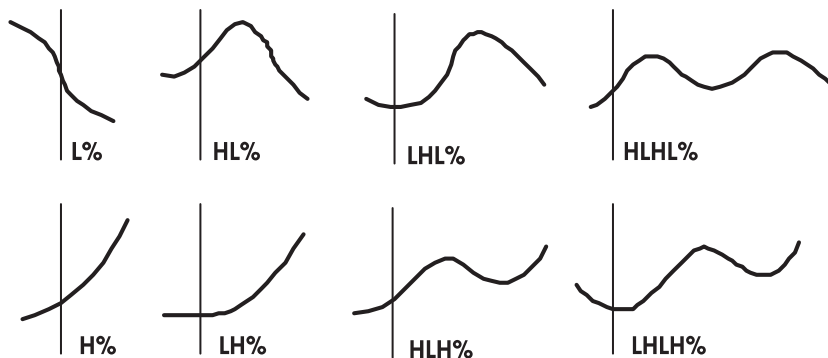


FIGURE 8.10 Schematic fo contours of eight boundary tones of IP.

Finally, for cases of uncertain or underspecified tonal events, for both AP and IP, use the following labels on the phonetic tone tier. Underspecified tone labels should be used when a labeller knows there is a tone, but has not assigned a label yet.

X	Underspecified tonal event of a non-AP-final tone. (Tone is there, but the tonal value has yet to be assigned.)
a	Underspecified AP-final tone.
%	Underspecified IP-final tone.
X?	Uncertain of the type of tone, which could be either an AP-final or IP-final boundary tone. (The labeller is not sure which of the two tone types to assign.)
Xa?	Uncertain of the type of AP-final boundary tone.
X%?	Uncertain of the type of IP-final boundary tone.

(iv) *The break indices tier*: break indices represent the degree of juncture perceived between each pair of words and between the final word and the silence at the end of the utterance. They are to be marked after all words that have been transcribed in the word tier. All junctures—including those after fragments and filled pauses—must be assigned an explicit break index value. Values for the break index are chosen from the following set. An example of a Break Index (BI) 0 is shown in Figure 8.11, and those of BIs 1, 2, 3 are shown in Figure 8.9. (The break index tier is named ‘break’.)

- 0 For cases of clear phonetic marks of ‘clitic’ groups; e.g. application of vowel coalescence rules. Also for cases of ‘incomplete nouns’ (monosyllabic nouns which, though separated by spaces, are seldom used by themselves but need a modifier; e.g. <su> ‘way’, <de> ‘place’, <gED> ‘thing’).
- 1 For phrase-internal ‘word’ boundaries which are not marked by such cliticization phenomena and can be pronounced independently.
- 2 For cases of a minimal phrasal disjuncture, with no strong subjective sense of pause—that is, a sense of phrase edge of the type that is typically associated with the Accentual Phrase final tone.
- 3 For cases of a strong phrasal disjuncture, with a strong subjective sense of pause (whether it be an objectively visible pause or only the ‘virtual pause’ cued by final lengthening)—that is, a sense of phrase break of the type that is typically associated with the boundary tone of an Intonation Phrase.

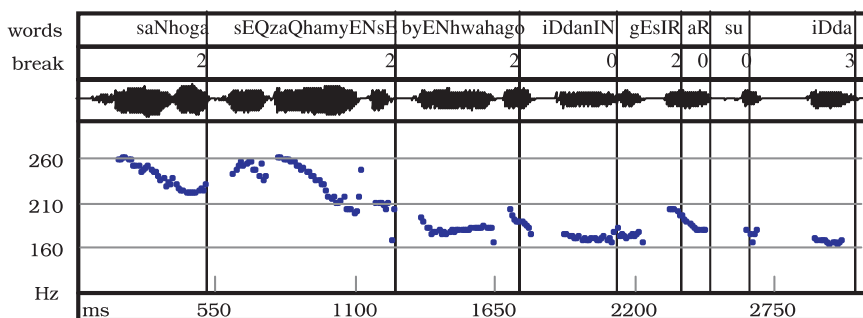


FIGURE 8.11 An example utterance, saNhogá ‘coral-NOM.’+sEQzaQhamyENsE ‘growing’+byENhwahago iDdanIN ‘change-prog.-rel.’+gEsIR ‘thing-ACC.’+aR su iDda ‘to see’ => ‘(We) can see that the coral is changing while growing’, illustrating BI o.

Note that while the AP and IP are defined in the prosodic model by tonal markings, the break index value indicates the labeller’s subjective sense of disjuncture and not simply the juncture that typifies the apparent tones. Thus, the break index tier markings for break index levels 2 and 3 are not made completely redundant by the tone tier markings. In cases of mismatch, the break index number should be chosen following the perceived juncture rather than the tones, and it should be flagged with the diacritic ‘m’. Though it is logically possible to have 1m, 2m, and 3m, ‘3m’ will not be found in data because an AP-final tone, L or H, is one of the IP-final tones. That is, there would be no such case as ‘3-like juncture with an AP-final tone, not an IP-final tone’. Definitions of 1m and 2m are given below. Figure 8.12 shows an example utterance of 1m (1-like juncture with Ha), and Figure 8.13 shows an example utterance of 2m (2-like juncture with no AP-final tone).

- 1m A disjuncture that typically would correspond to a phrase-medial word boundary, but is marked by the tonal pattern of an AP.
- 2m A medium strength disjuncture that typically would be marked by the tonal pattern of the AP, but has no tonal markings, or has the tonal markings of an IP edge.

Transcriber uncertainty about break-index strength is indicated with a minus (‘-’) diacritic affixed directly to the right of the higher break index (e.g. ‘1-’ to indicate uncertainty between ‘0’ and ‘1’; ‘2-’ to indicate uncertainty between ‘1’ and ‘2’). An example of BI 2- is shown in Figures 8.12 and 8.13. Note that since the ‘m’ diacritic suggests certainty about the break index

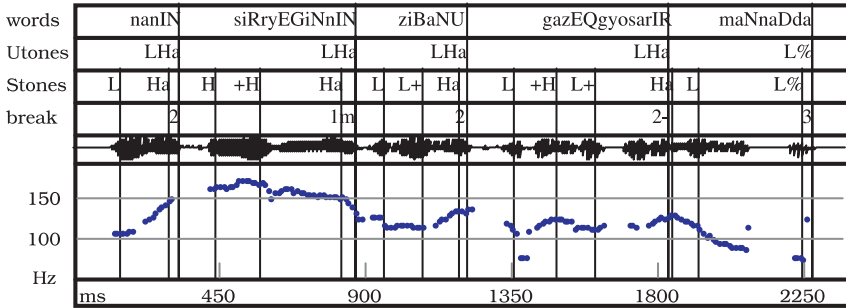


FIGURE 8.12 An example utterance, nanIN ‘I-TOP’+siRryEGiNnIN ‘powerful’+ziBaNU ‘family’s’+gazEQgyosarIR ‘tutor-ACC.’+maNnaDda ‘met’ => ‘I met the tutor of a powerful family’, illustrating BIs 1m, 2-, 2, and 3.

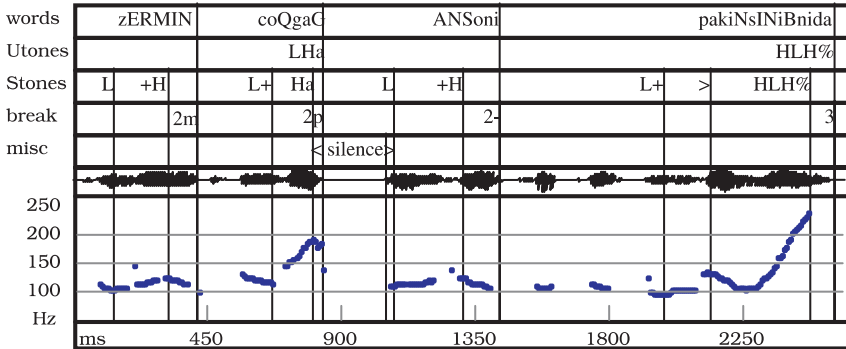


FIGURE 8.13 An example utterance, zERMIN ‘young’+coQgaG ‘bachelor’+ANSONi ‘Anthony’+pakiNsINiBnida ‘Parkinson-be’ => ‘(The firmly standing guard is) the young bachelor, Anthony Parkinson’, illustrating BIs 2m, 2-, 2p, and 3.

analysis in the face of conflicting tonal evidence, the ‘-’ diacritic should not be used together with ‘m’. Finally, a hesitational pause or disfluency after a word is labelled with a ‘p’ diacritic affixed directly to the right of the break index—e.g. ‘1p’ for abrupt cut offs after or in the middle of a word and ‘2p’ for prolongation of an AP-final syllable, but not meant to be IP final. An example of ‘2p’ is shown in Figure 8.13.

(v) *The miscellaneous tier*: the miscellaneous tier will be used for any comments on speech (e.g. silence, audible breaths, laughter, disfluencies) desired by particular transcription groups. The only conventions K-ToBI specifies for this tier are that events that cover some clearly specifiable interval (such as breaths, silence, or laughter) be labelled by the < . . . > pair, aligned

with both their temporal beginnings and ends. Event labels are written only before '>', as illustrated below. An example is shown in Figure 8.13. (The miscellaneous tier is named 'misc'.)

< beginning of an interval (e.g. laughter)
laughter> end of a period of laughter

8.4. LABELLER AGREEMENT

Analysis of labeller agreement and consistency in the transcription of Korean prosody using K-ToBI conventions described above has been performed based on twenty utterances representing five different types of speech (i.e., news, interview, text reading, story reading, and soap-opera) produced by eighteen speakers (Jun *et al.* 2000). Tones and break indices were transcribed by twenty-one labellers differing in their levels of experience with K-ToBI (five experts, six familiar with K-ToBI, five familiar with the British intonation model but new to K-ToBI, and five beginners). Following the stringent metric used for English ToBI evaluation (Silverman *et al.* 1992; Pitrelli *et al.* 1994), consistency was measured in terms of the number of transcriber pairs agreeing on the labelling of each particular word.

The results show that for tonal transcriptions of the 32,130 transcriber-pair-words, agreement was 77.3 per cent for the type of boundaries at the end of each word (i.e., word, AP, or IP), 77.5 per cent for AP boundaries, and 90.9 per cent for IP boundaries. For experts, agreement was 81.6 per cent, 81.9 per cent, and 90.9 per cent, respectively. For agreement on the surface realization of AP tones, agreement for the word-initial tone (L, H, no tone) was 82.3 per cent for all labellers and 90.7 per cent for experts, and that for the word-final tone (La, Ha, L, H, +H, L+, no tone) was 74.9 per cent for all labellers and 82.0 per cent for experts. About 11 per cent of AP-initial tones were not predictable from the segmental information (i.e., H when aspirated or tense consonants, and L otherwise), and about 16 per cent of AP-final tones were not rising but falling, i.e., La.

Agreement for the whole tonal pattern for each word, however, was only about 36 per cent for all labellers and 52 per cent for experts. This low agreement seems to be due to the nature of the tonal pattern. That is, there are fourteen possible AP tonal patterns whose surface variations do not seem to be meaningful or phonological. Furthermore, there is a gross similarity among some of the tonal patterns. For example, rising tonal patterns such as LH, LLH, and LHH are very similar to one another, and falling patterns such as LHLL and LHL are also very similar to each other.

For break indices excluding sentence final BIs, the agreement score among all labellers was 59 per cent for exact matching, 69 per cent when relaxing for the presence/absence of diacritics, and 99 per cent when relaxing within $+/-1$ level. The agreement score among experts was 65.5 per cent, 77.1 per cent, and 99.0 per cent, respectively. The results are, in general, close to those for English ToBI (66.6 per cent, 70.4 per cent, 92.5 per cent, respectively; Pitrelli *et al.* 1994) with somewhat lower results for exact matching (59 per cent vs. 66.6 per cent). Relaxing to the $+/-1$ level criterion results in higher agreement for Korean than for English most likely because Korean has four levels (0–3) of BIs, while English has five (0–4).

The results confirmed that the conventions of K-ToBI are adequate, easy to learn, and can be reliably used for research in Korean prosody and for large-scale prosodic annotation in speech databases. More data need to be transcribed to confirm these statistics and to find out the frequency and the function of the surface realization of AP tones and IP boundary tones as well as the detailed alignment of tones.

8.5. CONCLUSION

In this chapter, we have presented an overview of Korean intonational structure and the most updated version of K-ToBI labelling conventions. Korean has two prosodic units defined by intonation, Accentual Phrase and Intonation Phrase, and there are at least fourteen surface tonal patterns of an AP and nine types of IP boundary tones. The main revision of the current K-ToBI is splitting the tone tier into two tiers: the phonetic tone tier, labelling the surface tonal patterns of AP and IP boundary tones, and the phonological tone tier, labelling the tones marking the boundary of prosodic units, AP and IP. Labeller agreement data showed lower agreement percentage for surface tonal patterns than for tones marking prosodic boundaries, supporting the division between phonetic and phonological tones.

Korean has four degrees of juncture, one within a word and three between words. A diacritic 'm' is used after a break index when the degree of juncture corresponding to the break index does not match the expected tonal pattern. Agreement on the break index labelling was found to be similar to that of English ToBI. The agreement data showed that K-ToBI conventions are adequate and reliable. Transcribing more data using K-ToBI is needed to find distinctive meanings of tones and their realizations and to further improve K-ToBI conventions.

The current K-ToBI version (Version 3) of the K-ToBI manual is available on the website (<http://www.linguistics.ucla.edu/people/jun/sunah.htm>) and

also on the UCLA Phonetics Lab website (<http://www.linguistics.ucla.edu/faciliti/uclaplab.html>).

APPENDIX A: SUMMARY OF K-TOBI LABELS (TONES AND BREAK INDICES)

Tier	Label	Description	
Phonological tones	LHa	AP final boundary	
	L%	IP final low boundary tone. Declarative	
	H%	IP final high boundary tone. Interrogative	
	LH%	IP final rising boundary tone. Interrog., Cont. rising	
	HL%	IP final falling boundary tone. Declarative, Wh-Q	
	LHL%	IP final rising-falling boundary tone. Insisting	
	HLH%	IP final falling-rising boundary tone. Declarative.	
	LHLH%	IP final rising-falling-rising boundary tone. Insisting, Declarative, Intensifying some of LH% meaning	
	HLHL%	IP final falling-rising-falling boundary tone. Intensifying some of HL% meaning	
	LHLHL%	IP final rising-falling-rising-falling boundary tone.	
Phonetic tones	L	AP initial low tone (default for APs beginning with sonorants and lenis obstruents).	
	H	AP initial high tone (default for APs beginning with aspirated or tense obstruents).	
	+H	High tone on the second syllable of an AP. Optional	
	L+	Low tone on the penult of an AP. Optional	
	La	AP final low boundary tone.	
	Ha	AP final high boundary tone.	
	L%, H%, LH%, HL%, LHL%, HLH%, LHLH%, HLHL%, LHLHL%	— same as the IP tones on the phonological tone tier.	
	Break index	0	Reduced/cliticized word boundary.
		1	AP medial word boundary
		2	AP boundary
		3	IP boundary

m	Diacritic for mismatch. 1m: AP-med juncture with AP final tone; 2m: AP-final juncture with no AP or IP tone
-	Uncertainty between two adjacent break indices, ex. 3-: uncertain between BI ₂ and BI ₃ .
P	Diacritic for disfluency or hesitation pause
>	Delayed peak.

APPENDIX B

Romanization Convention^a

1. Consonants				2. Vowels		
Hangul	[IPA]	Roman letters	Hangul	[IPA]	Roman letters	
		Onset Coda				
ㅂ	[p]	b B	ㅏ	[ɑ]	a	
ㄷ	[t]	d D	ㅑ	[ɤ]	E	
ㄱ	[k]	g G	ㅓ	[o]	o	
ㅈ	[tʃ]	z D/z	ㅜ	[u]	u	
ㅍ	[p ^h]	p B/p	ㅡ	[ɨ]	I	
ㅌ	[t ^h]	t D/t	ㅣ	[i]	i	
ㅋ	[k ^h]	k G/k	ㅕ	[e/ɛ]	e	
ㅊ	[tʃ ^h]	c D/c	ㅛ	[ɛ]	A	
ㅍ*	[p*]	P —	ㅝ	[ɯi]	U	
ㄷ*	[t*]	T —	ㅟ	[ja]	ya	
ㄱ*	[k*]	K G/K	ㅠ	[jə]	yE	
ㅈ*	[tʃ*]	C D/C	ㅠ	[jo]	yo	
ㅅ	[s]	s D/s	ㅠ	[ju]	yu	
ㅆ	[s*]	S D/S	ㅞ	[je/jɛ]	ye	
ㅎ	[h]	h H	ㅟ	[jɛ]	yA	
ㄹ	[l/r]	r R	ㅘ	[wa]	Wa	
ㅁ	[m]	m M	ㅙ	[wə]	wE	
ㄴ	[n]	n N	ㅚ	[we/wɛ]	we	
ㅇ	[ŋ]	— Q	ㅜ	[we/wɛ]	We	
			ㅟ	[we/wɛ]	WA	
			ㅞ	[wi/ɥi]	wi	

^a Some of the Coda consonants are represented with two Roman letters separated by a slash. In this case, the first letter is for the Coda consonant followed by an Onset consonant, and the second letter is for the Coda consonant followed by a vowel, i.e., no Onset. This division reflects a neutralized Coda before a syllable with an Onset consonant (e.g. KoDziB 'a flower store') and a resyllabified Coda into an Onset before a Vowel initial syllable (e.g. Koci 'a flower-NOM.'). Two tense consonants, [p*] and [t*], occur as onsets only, and [ŋ] as a coda only.

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