Author Response to the Commentary: ToBI Is Not Designed to Be Phonetically Transparent

Sun-Ah Jun

Introduction

My essay for this chapter introduced how the tones and break indices (ToBI) transcription system works, and by referring to the ToBI systems of various languages, it discussed the strengths and challenges associated with the ToBI system and some of the recent developments made in response to such challenges. I was asked by the volume editors to present the ToBI system to relative newcomers to the field of prosody so that they can decide which transcription method is the one they are looking for, given their individual goals. I was also asked not to introduce the autosegment-metrical (AM) theory in depth, because this is addressed by Arvaniti (chapter 1, this volume). Therefore, my chapter was not about AM theory in general, but about ToBI in particular, and so AM theory was only described to the extent necessary to understand the ToBI system.

In their commentary, Dilley and Breen argue that AM theory has several serious problems, leading to limitations on ToBI*'s (= all ToBI-like annotation systems) value as a scientific tool. They summarized AM theory before criticizing it and introduced what they call an enhanced AM theory (AM^+). Their chief criticism of AM theory was that it does not include syntagmatic tonal relationships in phonology, which they also cite as a source of problems with ToBI*'s phonetic transparency and consistency (see "Enduring Insights from over Forty Years of Traditional AM Theory").

To fix this perceived problem, they included in AM^+ theory both syntagmatic and paradigmatic relationships of tones in the phonology and presented the rhythm and pitch (RaP) prosodic transcription system, which is an instantiation of their AM^+ theory. In this response, I will argue that Dilley and Breen's criticisms of (standard) AM theory and ToBI* are not fully justified, and in so doing, I will also highlight how AM theory and ToBI* are quite different from AM^+ theory and the RaP system.

The AM Theory versus the AM Model of English Intonation

In their commentary, Dilley and Breen list three main problems with AM theory that they claim are due to the assumption that the phonology lacks syntagmatic restrictions on tones: (i) complex phonetic rules and mechanisms for tone scaling that do not work, (ii) inconsistencies in mapping pitch accents to F0 events, and (iii) complications when F0 curves correspond to phonetic interpolation versus tones. They claimed that these problems in AM theory then translate to problems for systems like ToBI*, particularly the use of such systems for research on prosodic typology (see "Strictly Paradigmatic Phonological Representations"). However, these problems are mainly based on the AM model of English intonation proposed in Pierrehumbert (1980), and it should

be noted that the phonological categories and phonetic rules proposed for English intonation in Pierrehumbert (1980) and later works by Pierrehumbert and colleagues to explain surface F0 variations are specific to English, and thus do not apply equally to AM models of the intonational phonology of other, typologically different languages. What has been adopted from the AM model of English intonation by researchers working on models of other languages are instead the basic principles and assumptions of AM theory, such as:

- Intonation contours are analyzed as a linear sequence of two tonal targets, H (high) and L (low), and their combinations (e.g., bitones such as H + L or L + H).
- Unlike a single tone, a bitone has a close relationship between two adjacent tonal targets aligned to the hosting syllable or mora.
- Tones can have fundamentally different functions (marking prominence relations among words via pitch accents or marking the hierarchical structure of an utterance via boundary tones) and can change pragmatic or semantic meanings or cue syntactic structures.
- F0 heights of tones as well as the alignment of the tone-text matter are used in deciding a tonal category. If any of these differences changes the meaning or the prosodic structure of the utterance, that is, if any of them is distinctive, it should be coded into a tone.
- Pitch range can change throughout an utterance, reflecting the degree of prominence, the informational status of a word, the pragmatic and discourse meaning of a phrase, and the prosodic phrasing of the utterance.
- Prosodic phrasing can be defined by pitch-range reset as well as by the degree of phrase-final lengthening and the presence of a boundary tone.

MAE_ToBI versus ToBI*

It is also important to highlight that English ToBI, or more specifically, MAE_ToBI (Mainstream American English tones and break indices), is not a direct instantiation of the AM model of English intonation proposed by Pierrehumbert (1980). As Beckman, Hirschberg, and Shattuck-Hufnagel (2005) noted, a great deal of literature preceding Pierrehumbert (1980) and Beckman and Pierrehumbert (1986) contributed to the development of the MAE_ToBI. Furthermore, when a ToBI system is developed for a language whose prosodic system is quite different from English (for example, languages like Korean that lack both lexical stress and intonational pitch accent), some of the main principles proposed in MAE_ToBI had to be modified or extended, as mentioned in my essay. Therefore, criticisms of language-specific implementations like MAE_ToBI do not straightforwardly apply to ToBI* generally, and Dilley and Breen's argumentation is rather misleading in this regard.

Difficulties with Using ToBI* for Studying Prosodic Typology

Dilley and Breen claim that AM theory's lack of syntagmatic phonological restrictions on tones has led to difficulties in using ToBI* for prosodic typology, citing Hualde and Prieto (2016). However, the difficulties that Hualde and Prieto discuss are not at all specific to ToBI*, nor are they related to a lack of syntagmatic phonological specifications. Rather, the difficulties that emerge are due to ToBI*'s status as a phonological transcription system. In fact, this was one of the primary challenges to the ToBI system

that is highlighted in my essay: there are inherent limits to the use of such a system for the purposes of typological description. Phonological contrasts are by nature language-specific, and thus the same tonal label can "mean" different things across languages—just as is seen in typological study of segmental sound patterns. Typological study therefore requires consideration of both phonological and phonetic components of the target languages' sound systems, and difficulties will arise if either is ignored. To study prosodic typology, the AM approach to intonation would provide evidence primarily regarding phonological contrasts, and thus we would need to look elsewhere for evidence bearing on the relevant aspects of phonetic realization. Such evidence could come from acoustic data, but, as noted in my essay, it could also come from phonetically transparent labels of the sort being developed for an IPrA (international prosodic alphabet). As a phonological transcription system, ToBI* is neither intended to be nor expected to be phonetically transparent, and so its lack of phonetic transparency is a poor basis for criticism. Indeed, the fact that it is possible to use some ToBI labels in a phonetically transparent way, or to mix phonological and phonetic labels, was cited as one of the weaknesses of ToBI* in my essay. If a transcription system is phonetically transparent—that is, its labels pick out nondistinctive surface prosodic properties—it cannot and should not be used as a phonological transcription system.

Syntagmatic Tonal Relationships in AM Theory

There is no question that we need to consider both paradigmatic and syntagmatic properties of tones in the study of tone and intonation. As rightly pointed out in Dilley and Breen's commentary, Pierrehumbert (1980) and Pierrehumbert and Beckman (1988) did not ignore syntagmatic relationships for underlying tonal representations; although Pierrehumbert (1980) and later works on the AM model of English intonation (including Beckman and Pierrehumbert 1986) defined the L and H tonal targets paradigmatically by referring to the pitch range of a speaker at a given point in an utterance, they did include syntagmatic relationships among tones in phonology. This is, for example, evidenced in their inventory of bitonal pitch accents (e.g., L + H*, L* + H, H + L*) and the addition of an H* + L ("floating L" tone) to capture the downstep relation between two adjacent H tones. In fact, their AM model of English was not the first model to codify the importance of syntagmatic tonal relations to English intonation, as the matter was also central to earlier debate over levels versus configurations (see discussion in Bolinger 1951). Pierrehumbert (1980) and later works made their approach distinct from the earlier research by proposing that underlying tonal representations were simpler and more abstract (by allowing only two tonal levels, instead of four as in Trager and Smith 1951) and by deriving the various nondistinctive surface realizations of underlying tones in the phonetic component of the grammar. As mentioned in my essay, the surface F0 variations, including the relative F0 height of a sequence of singleton pitch accents, are explained by the degree of prominence, a tone's lexical status, and the type of tone sequence. Importantly, these factors cover both paradigmatic (e.g., the top reference line of nuclear H*'s pitch range can be higher than that of non-nuclear H*'s) and syntagmatic relationships (e.g., H% is realized higher than the preceding H-; L% is lower than the L of L + H*) of tones. Thus, a central tenet of AM theory is to allow only distinctive tonal events in the underlying representation. Any f0 events that are nondistinctive, predictable, or unmarked (e.g., a speaker's medium/unmarked F0 level at the onset of an utterance) are outside of the phonological component of the grammar.

Dilley and Breen criticized AM theory for not including syntagmatic tonal relationships in phonology, stating in their "Summary" section: "Fortunately, ToBI* systems have been used by communities of scholars as though syntagmatic tonal relationships are part of the phonology, even though they are not. For example, scholars have annotated L + H* as a low valley plus a rising pitch." However, as mentioned herein, the AM model of English intonation proposed in Pierrehumbert (1980) and revised in Beckman and Pierrehumbert (1986) explicitly treated syntagmatic tonal relationships as part of the phonology and specified how bitonal pitch accents differ from singleton pitch accents. For example, Beckman and Pierrehumbert specified that "the difference between L* + H and H* involves contrast not only in the timing of peak but also in the F0 level immediately preceding the peak. The L* + H accent has a valley on the stressed syllable which is as low as that for any L* accent whereas the H* accent has no such valley" (259). The MAE_ToBI manual (Beckman and Ayers-Elam 1997) further illustrates in section 2.2 how L + H* is acoustically different from H* or from a sequence of L* and H*. Section 2.6 of the manual also illustrates how L + H* is acoustically different from L* + H, and the alignment difference is distinctive in English, demonstrating that the timing of the F0 rise relative to the accented syllable can be also phonological. Therefore, it is natural and expected that ToBI systems of other languages have included syntagmatic tonal relationships as part of phonology.

AM$^+$ Theory and the RaP Prosodic Transcription System

The details of AM$^+$ theory and the RaP prosodic transcription system, as described in Dilley and Breen's commentary, suggest that the goal of AM$^+$ is to make a prosodic transcription phonetically transparent and to provide a theory for such transcriptions. Indeed, "phonetically transparent" is explicit both in the commentary's title and their note 12 about the AM$^+$ theory validating the INTSINT (International Transcription System for Intonation) approach (Hirst and Di Cristo 1998, and Hirst, chapter 3, this volume). INTSINT is known as a narrow phonetic transcription of F0 contours.

To achieve such a goal, AM$^+$ and RaP are designed to transcribe F0 changes (turning points and slope changes) in terms of symbols representing syntagmatic tonal relationships. However, it seems that phonetic transparency is enhanced in RaP not because the AM$^+$ prioritizes syntagmatic tonal relationships (as Dilley and Breen emphasize throughout their commentary), but because the AM$^+$ theory made its "phonological" component very rich and its categories very fine-grained. The phonological component in their theory includes three features capturing syntagmatic tonal relationships—[same], [higher], and [small][1]—as well as other categories (with a few restrictions on their combination). Because the feature values of [higher] or [small] are specified only with [–same], combinations of these three features will generate five types of syntagmatic relationships between two adjacent tones, represented by five symbols in RaP: **H, !H, E, !L, L**. (Following the convention used in the commentary, I will mark the RaP symbols in bold.) **H** is for a tone that has the feature specifications [–same, +higher], **L** for those with [–same, –higher], **E** for [+same], **!H** for [–same, +higher, +small], and **!L** for [–same, –higher, +small]. In addition to these five symbols for syntagmatic F0 targets, RaP includes the **+** symbol to represent the association of an unstarred tone (on a nonprominent syllable) to an adjacent starred tone (on a prominent syllable). **+** can be put on the right side or to the left side of any unstarred tone symbol (meaning an unstarred tone can come before or after a starred tone), theoretically creating multiple combinations (e.g., **H* +L, H* +E, H+ L*, H+ E*, L* +H, L+ H*, L* +E, E+ L*, E* +H, !H* +H, H+**

!L*). Furthermore, RaP posits three phrase-initial phonological tones, designated by :, namely, **:L H** (omitting + and *) for a rise, **:H L** for a fall, and **:E E** for a level pitch, and it does not restrict the number of phrase-final tones (e.g., **H%, HH%**). Having all of these categories, AM+/RaP would easily allow for the transcription of all possible F0 contours in English or any other language at the phonetic level. At the phonological level, however, it would predict many more tonal contrasts than any one language could have, and at the same time, it would generate many impossible or unobserved F0 contours, suggesting that AM+ has a problem of overgeneration as a phonological model.

To illustrate their system's capacity for phonetic transparency, Dilley and Breen proposed RaP tonal labels for a few cases that pose well-known challenges for pitch accent categories in ToBI. First, they proposed labeling the H* versus L + H* in MAE_ToBI as **L+ !H*** versus **L+ H***, respectively, in RaP. This would allow their system to capture the difference between a small rise to a peak for H* versus a large rise to a peak for L + H* in English. However, these two RaP labels misrepresent the tonal contrast of the two pitch-accent types in English. While it is true that F0 is generally higher for L + H* than H*, it is the presence or absence of the preceding L tone target, not the height of the H target, which is distinctive in English; L + H* requires a low F0 target immediately before the H* target, but H* does not. For H*, F0 rises gradually toward the H* target and no L target should be adjacent to it. In fact, F0 does not have to rise to a peak at all to be labeled as H*; an H* can be preceded by a high F0 (e.g., a "hat pattern"). Labeling ToBI's H* as **L+ !H*** in RaP further suggests that the symbol **!H** refers to a small, local F0 rise toward a single high target, independent of the F0 level of the preceding H tone. That is, RaP would allow **!H** to occur as the first H tone of a phrase, because **!H** does not indicate that the H target is lower than a preceding H as it does in MAE_ToBI. A **!L** symbol is used in RaP to represent an F0 target slightly lower than the preceding tone. Thus the **!H** symbol does not serve the purpose of capturing the global pitch range reduction applied to all post-!H tones as it does in MAE_ToBI. And it is not clear how this phenomenon of global pitch-range reduction (beyond the window of syntagmatic relation between two adjacent tonal targets) can be represented, even on higher grid tiers, in RaP. While RaP could mark lowered pitch range with a specific diacritic before each affected tone, this would not really capture the global effect.

The idea of using **!H** to denote a local tone level for a small rise to a peak compared to a large rise to a peak is also exemplified in their proposal for Greek prenuclear pitch accents, for which they assign **L+ !H* +H**. One might think that this label closely matches what is observed in the surface F0 contour, namely, the low F0 valley before the accented syllable whose F0 is slightly lower than that of the postaccented syllable. However, this would work only if the label represents paradigmatic tonal height, which is not the case in RaP. Furthermore, given the phonological constraints on assigning pitch accent status in the AM+ theory—a metrically prominent syllable without any local pitch change is not considered a pitch accent—the **L+ !H* +H** label in RaP would not match the described surface F0 contour because this label would imply a change in the rising F0 slope during the rise (i.e., from **L+ !H*** to **!H* +H**). However, as described in detail in the literature on Greek intonation (Arvaniti and Baltazani 2005; Arvaniti, Ladd, and Mennen 1998, 2006), the prenuclear pitch accent in Greek is a simple rising tone, with a low F0 valley anchored at the preaccented syllable and a high f0 peak anchored at the postaccented syllable. Because there is no slope change in the middle of the rising F0, this rising contour would be labeled as **L+ H** in RaP (i.e., an **L+** on the pre-accented syllable and an **H** on the postaccented syllable) without any intervening tone. Consequently, the prenuclear pitch accent in Greek would not be represented

as a pitch accent in RaP at all; instead, only the prominence of the accented syllable would be marked (as **x**, for "weak prominence level") on the rhythm tier. In sum, their proposal of L+ !H* +H does not capture the F0 contour of the prenuclear pitch accent in Greek, illustrating that the AM$^+$/RaP system encounters a problem of undergeneration. This problem would disappear if pitch accent were not defined only by pitch "movements" but by a combination of pitch and other acoustic properties such as increased intensity and duration as well as the clarity of segment articulation. This then could also correctly capture the cases where a sequence of three prominent words is realized in the same pitch height.

Finally, RaP is designed to be phonetically transparent and thus make the surface F0 contours more easily recoverable from its labels. Yet the system's emphasis on syntagmatic tonal relationships to the exclusion of all paradigmatic height contrasts may actually hinder recoverability in some cases. For example, consider AM$^+$'s use of the **E** symbol, which refers to a tone having an F0 target equal in height to that of a previous tone. Because **E** only means "equal to previous F0," the symbol **E** itself is not phonetically transparent; we need to look at the following or preceding tone label to know the value of **E**. Thus, **H* +E** means **E** = H, and **E* +L** means **E** = H or !H (i.e., any tone but L), but the interpretation of **E** in a label such as **:E E+ !L*** is not as simple. It would mean a phrase-initial flat F0 followed by a slight lowering of F0. This tells us about the shape of an F0 contour but not about the phonetic value of the F0 plateau, which can be high, mid, or even low. Similarly, because the five tonal symbols in RaP are all representing relative F0 heights in comparison to the previous and sometimes following F0, recovering the F0 values for the symbols would require a much larger utterance domain (or a greater number of symbols) than would be required if using ToBI labels. And the idea that such a wide domain is perceptually necessary is in contradiction to the findings from studies on the perception of pitch targets that Dilley and Breen cite in their commentary (i.e., Bishop and Keating 2012; Honorof and Whalen 2005). It seems unlikely that these problems can be avoided unless tonal labels reflect both paradigmatic and syntagmatic tonal relationships.

Conclusion

Presenting AM$^+$ theory as an "enhanced AM" theory implies that it is a phonological theory. However, a phonological theory of intonation should make predictions about possible or impossible tonal contours of a language. It is not clear how AM$^+$ does this. It is also not clear whether the AM$^+$ model of English intonation can accommodate any fixed inventory of tonal elements or a syntax of their combination. With such a rich set of tonal symbols generated from syntagmatic tonal features and diacritics, AM$^+$ theory would certainly "facilitate" phonetically transparent prosodic annotation. However, as a theory of linguistic pitch, it captures more tonal contrasts than is found in any language, that is, it overgenerates, and in some cases it does not capture distinctive tonal contrasts, that is, it also undergenerates. If a model is only adequate for describing F0 contours by using phonetically transparent labels but that model cannot make predictions about possible or impossible tonal contours, there is no sense in which the model is truly a phonological model. That being the case, it seems that the central difference between AM and AM$^+$ is not the absence versus presence of syntagmatic tonal relationships in phonology—or about the difference in the division of labor between the phonetics and the phonology—but instead whether what is being modeled is even phonology or not.

However, given that RaP is a hybrid transcription system of phonology and phonetics, the issue is not straightforward. Though the "rhythm" aspect of RaP was not described in great detail by Dilley and Breen in their commentary, RaP's rhythm tier encodes the prominence relations among words, as well as the prosodic structure of an utterance—both of which are phonological properties. (These two types of information are labeled on the phonology tier in the PoLaR [points, levels and ranges] annotation system [Ahn, Shattuck-Hufnagel, and Veilleux 2018], which is the most recent annotation system developed to address some of the challenges of the ToBI system.) The pitch tier in RaP, however, captures a mixture of phonological and phonetic properties. In terms of phonological properties, it allows for (i) the transcription of prominence-lending pitch changes (the equivalent to pitch accents in their system, marked with *****) and (ii) the association between unstarred tones and starred tones (marked with **+**), distinguishing a bitonal pitch accent from a singleton pitch accent. In terms of phonetic properties, it allows for (i) transcribing small changes in pitch level (marked by !) in both upward and downward directions relative to the preceding F0 target and (ii) transcribing any changes (in direction or slope) displayed in an F0 contour. These changes are transcribed without any regard to whether they are contrastive (e.g., labeling phrase-initial medium level F0; labeling H* as an F0 rise, **L+ H**). Therefore, it is important to highlight that RaP is not simply a separation of ToBI's tones tier into two tiers, rhythm and pitch. Although RaP's rhythm tier includes information very similar to the marking of prominence and metrical/prosodic structure on ToBI's tones tier, RaP's pitch tier includes tonal labels that are much more phonetic than ToBI's tonal categories. In fact, the tonal labels on RaP's pitch tier are similar to those of INTSINT, in that both systems label phrase-medial F0 changes based on syntagmatic tonal relationships. At the same time, RaP's pitch tier includes more phonological information about F0 than INTSINT does, because the pitch tier represents an association between tones based on their prominence and alignment to a syllable. However, even though RaP's pitch tier is more phonological than INTSINT, it is less phonological than IPrA because RaP's pitch labels annotate finer differences in F0 than IPrA does.

In sum, ToBI* was designed to be a phonological transcription system, using L and H tonal symbols that capture contrastive tonal events marking either prominence relationships among words or the metrical and prosodic structure of an utterance. As such, the goal of a ToBI transcription is not to recover surface F0 contours like a close copy, but to represent and analyze contours in terms of contrastive tonal categories. Moreover, ToBI is not only a tool for a phonological transcription of an utterance's prosody; it is also a powerful tool for studying prosody and intonation and their interaction with various phenomena in any subfield of linguistics. However, because many researchers in recent years have acknowledged the need to transcribe nondistinctive surface tonal events in addition to the distinctive tonal events, developing transcription systems for nondistinctive F0 events should be encouraged, and these transcription systems should be used in addition to ToBI, but not as a replacement for ToBI transcription.

Note

1. Dilley and Breen say that the phonological representations in AM^{+} are based on two features, [+/– same] and [+/– higher], but later, they introduced [+small] to capture a slope change in rising or falling F0 in English and Greek intonation contours. Yet both [+/–] feature values of [small] are included in their representation of paradigmatic tone specifications, as shown in their table 4c.1.

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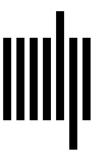

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