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## Tones and Intonation: Some Current Challenges

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### Abstract

*It is well established that lexical tones and intonation are not mutually exclusive. Moreover, the presence or absence of lexical tones in a language does not by itself constitute a fundamental typological divide for intonation systems. Two dimensions of typological diversity are brought out: (i) concerning lexical tone systems, it is suggested that the analysis of contour tones into sequences of levels, which has clearly demonstrated its validity for numerous languages, does not actually apply to all; (ii) concerning intonation systems, it is suggested that languages differ in whether – and to what extent – they have ‘intonational tones’, i.e. tones of intonational origin that are structurally similar to lexical tones. ‘Intonational tones’ strictly speaking appear to be relatively rare.*

*A hypothesis is set out concerning the relationship between the nature of the lexical tone system of a language and that of its intonation system: it is suggested that the encoding of intonational phenomena in terms of tones tends to thrive in languages that have a lexical system of level tones – by a process of tonal reinterpretation of intonation – whereas languages that have non-decomposable contour tones tend not to have tonal intonation.*

### 1 Introduction

It was a pleasure to receive the organisers’ invitation to discuss “Prosody in tone languages”. Observing lexical tones is a promising starting-point to disentangle the complex phenomena that go to make prosody, viz. lexically distinctive tone or stress, on the one hand, and intonation on the other [1]. Historically, the study of Subsaharan tone systems has had considerable influence on the development of

autosegmental models of tone [2]; in turn, these models of tone inspired the ‘autosegmental-metrical’ models of intonation. In autosegmental-metrical models, “Lexical pitch variations and intonational pitch variations are phonologically represented as tones, like H(igh) and L(ow)” [3:xvii]. The daring theoretical move which consists in modelling lexical tones and intonation with the same phonological concept – tone – receives support from some tonal languages. There are well-established cases where intonation is encoded by tones that are treated on a par with lexical tones (section 3.1 provides examples); these cases will be referred to below as ‘tonal intonation’.<sup>1</sup> However, a typological overview suggests that tonal intonation is relatively infrequent.

On a personal note, I am fortunate to have studied both a language which can serve as a textbook example of level-tone system, and in which a part (albeit only a small part) of intonation is encoded in tonal terms – the Tibeto-Burman language Naxi – and another tonal language – Vietnamese – that appears to be structured in a very different way. The pervasive intonational phenomena of Vietnamese are not encoded by tones: intonation results in noncategorical modifications of the lexical tones. The present paper is an attempt to arrive at a common typological framework within which both types of systems – and, ultimately, all systems – can be adequately described. Ideally, this typological framework should allow both for the description of lexical tone systems and of intonation systems. These two dimensions are dealt with in sections 2 and 3 respectively; section 4 discusses their relationship.

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<sup>1</sup> Note that this use of the phrase differs crucially from that in [4], where *tonal* vs. *non-tonal* means *realised by  $F_0$*  vs. *realised by parameters other than  $F_0$* , i.e. adopting a very different perspective from that of the present research.

## 2 The diversity of tonal systems

### 2.1 ‘Beyond stress and tone’: usefulness and limitations of prototypes

It is well established that prosodic systems do not fall neatly into a limited number of classes. The riveting issues encountered in the analysis of prosodic systems that have both tonal and accentual properties has led to much attention being focussed on these systems, “between stress and tone” (the name of a conference held in 2005). A major issue has been whether prosodic typology should be based on a two-term opposition between stress and tone, languages such as Japanese and Luganda being considered to “‘pick and choose’ various properties which tend to cluster in prototypical stress vs. tone systems” [5:656]. It has been pointed out that tonal systems are actually very diverse [6:264], raising the issue of what is meant by tone as a prototype. There are various contenders for the title of prototypical tone language [7]: the tonal system of Kunama (Nilo-Saharan), with its three level tones that associate at the level of the mora [cited by 8:141-142] differs in numerous respects from that of Vietnamese (Austroasiatic), whose phonetically complex syllable tones [9:121-123, 10] illustrate the important fact that linguistic tone should not simply be equated with  $F_0$ .  $F_0$  is the defining property of tones in the vast majority of the world’s prosodic systems. However, there also exist tones that cannot be reduced to  $F_0$  [11]; general phonological models of tone obviously need to take these cases into account, even though the languages at issue may be relatively few in number. Section 2.2 addresses another important dimension of tonal diversity: contour tones.

### 2.2 How much evidence is there for the analysis of contour tones into tonal sequences?

In many languages, there is a wealth of evidence for the analysis of contour tones into tonal sequences. A rising tone in an African language will typically exhibit phonological behaviour showing that it consists of a low tone followed by a high tone [see, e.g., 12]. This insight of autosegmental analyses of tone has proved its usefulness far beyond the geographic domain to which it had first been applied. In the Far East, similar observations have been made on a number of languages (including Naxi: [13]).

These remarkable successes naturally lead up to the hypothesis that contour tones in all languages can be analysed as sequences of level tones.

However, there are some languages for which attempts at the decomposition of contours into levels has been less successful, to the point of casting doubt on the relevance of decomposition. Surprisingly, in the Austroasiatic and Tai-Kadai language families, no convincing evidence is found for the decomposition of contour tones into simpler units. In the case of Vietnamese, this has led several researchers to conclude that the decomposition of lexical tones into sequences of levels did not appear useful or adequate [10, 9]. In the case of Thai, there is still a debate as to whether the five tones of Standard Thai are to be considered as undecomposable wholes, or analysed as three level tones and two contour tones, the latter consisting of sequences of level tones. Despite several attempts [the most recent of which is 14], the usefulness of decomposition cannot actually be considered as proven, for want of compelling language-internal phonological evidence.

Admittedly, acknowledging the existence of unitary contour tones may sound like a negative conclusion – the failure of attempts at analysis. Verification of the hypothesis that unitary contours do exist would actually require positive evidence, not merely negative evidence. One should demonstrate that the ‘unitary contours’ hypothesis, applied to a language such as Vietnamese or Thai, yields some linguistic insights which would be missed under a level-tone account. This hypothesis should lead to some verifiable predictions.

Such evidence is not easy to obtain. As a first step in this direction, I suggest that some such evidence could be found in the diachronic evolution of tones.

As a working hypothesis, it would seem that the diachronic evolution of level tones (and hence of decomposable contours) takes place through categorical phonological changes: under certain circumstances, intonational differences in tone production – i.e. intonation-conditioned allotonic variation – can give rise to a categorical change in tone, i.e. a change in the phonological system. For instance, a slight phonetic raising of a H tone preceding a L tone has been noted in various tone languages: taking the Gulmancema data in table 1 as an example, the syllable  ${}^H\text{kan}/$  will be realised phonetically higher in the sequence  $/{}^{LM}o\ {}^H\text{kan}\ {}^Ldi/$  than in  $/{}^{LM}o\ {}^H\text{kan}\ {}^Hdi/$ . This phonetic phenomenon

does not affect the phonological nature of the tones. In the closely related language Moba, on the other hand, the super-high phonetic variant of the high tone has gained contrastive status – i.e. a lexical extra-high tone has emerged – following the loss of word-final vowels.

**Table 1.** A comparison showing the origin of the extra-high tone of Moba. Data and analysis from [15:317].

meaning	Gulmancema	Moba
he stepped over	<sup>LM</sup> <sub>o</sub> <sup>H</sup> kan <sup>L</sup> di ( ð kándì )	<sup>LM</sup> <sub>u</sub> <sup>XH</sup> kant ( ù kǎnt )
he steps over	<sup>LM</sup> <sub>o</sub> <sup>H</sup> kan <sup>H</sup> di ( ð kándí )	<sup>LM</sup> <sub>u</sub> <sup>H</sup> kant ( ù kánt )

This is a case of transphonologisation (transfer of distinctiveness): from the tone of the word-final vowel to the one that precedes. The allotonic variation paves the way for the diachronic change, but the impetus for the change comes from the loss of final vowels.

It is not expected that, in a tonal system which hinges on a binary opposition between H and L tonal levels, the two terms of the opposition will undergo a gradual phonetic evolution away from their original values, e.g. the H gradually becoming falling (changing to HL). By contrast, unitary contours appear to undergo gradual change, due to the continuous effect of phonetic factors; unlike in the case of the change attested by the comparison of Gulmancema with Moba, the evolution of unitary contours takes place without any obvious phonological change. Unitary contour tones appear to be defined in terms of an overall shape, which can vary somewhat so long as the contrast among the tones present in the language is preserved. There are no absolute points of references to define such contours, unlike level tones. This working hypothesis appears to be verified in the case of Bangkok Thai, which has been documented experimentally at intervals for the past 100 years. To take an example, the tone which in 1908 was the highest, with a final fall, has now become rising (see fig. 2 of [16]). The number of distinctive tones has remained the same; their phonetic evolution appears to be gradual. This represents a challenge for an account of this language in terms of level tones: in addition to proposing a synchronic analysis, one would have to propose

plausible evolutionary processes to account for these changes, and to obtain evidence of these processes.

To sum up, the case for the decomposition of contours is extremely clear in many – but not all – languages, whereas positive evidence for non-decomposable tones is difficult to obtain; the above data from Gulmancema/Moba on the one hand, Thai on the other, are not directly comparable, in that the first constitute a case of transphonologisation, whereas the second are phonetic observations on language evolution in the absence of phonological change. Diachronic models of change for various types of tone systems could perhaps shed further light on this issue, which at present must be considered to remain unsettled. Provisionally, it appears reasonable to maintain that there exists a class of contour tones (some of which involve phonation type characteristics, as in Vietnamese), distinct from level tones; the relative rarity of such tonal systems, and the difficulty of providing positive evidence for unitary-contour analyses, do not amount to a proof of the non-existence of such systems.

### 3 Tonal and non-tonal intonation

Section 2 offered some remarks about the diversity of tone systems; section 3 addresses the distinction between tonal and non-tonal intonation.

Intonation contributes to shaping the phonetic realisation of tones, just as it contributes to shaping the realisation of phonemes. These dimensions are the same for languages that have tone as for those that do not. Here is one out of several possible functional classifications of these dimensions [17, 1]:

- (i) the intonational marking of boundaries/junctures – a dimension very strongly linked to syntax;
- (ii) the intonational marking of information structure – i.e. the pragmatic dimension of intonation;
- (iii) the expression of attitudes and emotions.

A major difference across languages is to what extent (if at all) each of these components of intonation is structured in tonal terms. Examples are provided below.

### 3.1 Motivation for the distinction between tonal and non-tonal intonation

In some languages, certain junctures of the utterance are characterised by the addition of boundary tones, which, though introduced by post-lexical rules, are integrated into the tone sequence of the utterance on a par with lexical tones. Such phenomena will be referred to here as tonal intonation (a phrase used in a different sense by [4]: see footnote to p. 1). L. Hyman (p.c.) points out that such phenomena are “rampant in African tone systems”. For instance, in Luganda, there is a phrase-final boundary tone (H%) which acts just like any level tone, except that it is inserted into the tonal string later than the lexical tones. Any sequence of preceding toneless moras will be raised to that H level (though there has to remain at least one L before it). For example, /omulimi/ ‘farmer’ is pronounced all-L as subject of a sentence (/òmùlìmi/), but at the end of an utterance marked by this H%, it is pronounced L-H-H-H: /òmùlímí/.

I was lucky to encounter a clear instance of tonal intonation in a Tibeto-Burman language: in Naxi, a tonal language of China, a word that carries lexical L or M(id) on its last syllable can receive intensification (‘focusing’) by addition of a H tone that aligns at the right edge of the word, changing the tone of the last syllable to a rising contour tone [13:72]. This is a distinct phenomenon from emphatic stress (also present in Naxi): the former is tonal, the latter is not.

In contrast to such instances of *tonal* intonation, *non-tonal* intonation is here defined as that part of intonation which is not implemented by the addition of tones. For instance, Mandarin Chinese and Vietnamese have very salient intonational phenomena, which, though they have a strong influence on the phonetic realisation of the lexical tones, do not modify their phonological identity. This has been known, for Chinese, since the pioneering work of Chao Yuen-ren [18]. Chao’s intuitions have been confirmed by subsequent experimental studies [e.g. 19], and also by the development of speech synthesis, where it was found necessary to specify, along with a syllable’s lexical tone, its “strength coefficient” [20]: this coefficient, which reflects informational prominence, plays a major role in the speech synthesis system, determining the actual shape of the final  $F_0$  curve. This synthesis system thus provides indirect confirmation of the linguistic

observation that, although intonational parameters interact with the phonetic realisation of tone, they do not modify the underlying phonological sequence of tones (i.e. there is no insertion or deletion of tones). In extreme cases, intonation may be so strong as to override the lexical tone, but from the point of view of linguistic structure it remains on an altogether different plane from lexical tones.

Thus, languages differ in the amount of tonal intonation that they have; in some cases, it is debatable whether intonation is to be at all modeled in terms of tones – e.g. major difficulties with the notion of ‘tonal intonation’ as applied to French and English are pointed out by [21] and [22:89]. I have tentatively proposed a typological perspective whereby prosodic systems could be characterised in terms of the degree to which they rely on the calculation of tone sequences [23].

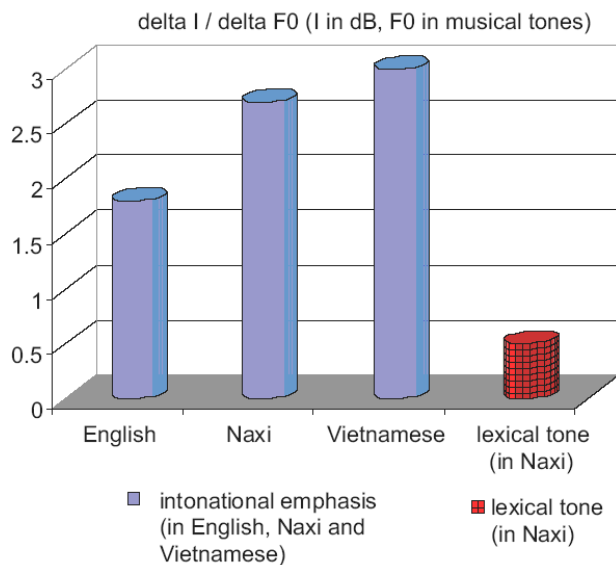
### 3.2 An experiment comparing intonational phenomena in English and two tonal languages

This section reports on an experiment comparing local intonational phenomena in British English and in two languages that have lexical tones: Hanoi Vietnamese (Austroasiatic) and Naxi (Tibeto-Burman). The same words, placed in carrier sentences, were recorded under two reading conditions: (i) ‘careful reading’, as if teaching a foreign student; (ii) ‘emphatic reading’, as if addressing a child who is asking for the umpteenth time how a word is pronounced. The latter reading has an emotional tinge, conveying impatience. A similar experimental setup was used in the three languages. In Naxi, monosyllables of the three tonal categories H(igh), M(id) and L(ow) were used; in Vietnamese, two tones which differ sharply in terms of phonation type were chosen: the one with final glottal constriction, the other with gradual vocal fold abduction. The measurements include  $F_0$ , global acoustic intensity, duration, and an estimation of the glottal open quotient by electroglottography. For details on the language materials, method and results, see [24:107-164].

In Naxi, whose prosodic system is structured in terms of three tonal levels (H, M and L),  $F_0$  and intensity are higher under the ‘emphatic’ reading condition, but the difference in terms of  $F_0$  across reading conditions is smaller than in English and in Vietnamese. In Vietnamese,  $F_0$  is clearly different

between the two reading conditions, whilst phonation type, which is an important component of the definition of the tones, is almost identical. These observations suggest that lexical specifications over a phonetic dimension – such as  $F_0$  or phonation type – “place a damper” on its intonational use (to borrow a phrase from L. Hyman), without suppressing it altogether. The speakers of Naxi appear to control  $F_0$  level – the defining phonological property of tone in Naxi – more strictly than speakers of Vietnamese. Intonational freedom is greatest in English, as could be expected on the basis of the absence of tone and of the high functional load of intonation in conveying pragmatic information in English. Phonation type is controlled tightly in Hanoi Vietnamese, where it is part of the definition of tones, than in Naxi or English.

Graph 1 shows the ratio of differences in intensity (mean RMS amplitude) to differences in  $F_0$  ( $\Delta I / \Delta F_0$ ), which was calculated across the two reading conditions for the three languages, and across the lexical tones H and M of Naxi.



**Graph 1.** Values of  $\Delta I / \Delta F_0$  in the comparison of the two reading conditions for the three languages (three first columns) and in the comparison of M and H tones in Naxi (last column). 14 speakers.

Looking at the Naxi data alone, the comparison of differences in intonational emphasis, on the one hand, and of tonal differences, on the other, shows that the ratio  $\Delta I / \Delta F_0$  is higher for intonational emphasis than

for differences across lexical tones. This suggests that, while emphasis is reflected in  $F_0$  in all three languages, its phonetic realisation is by no means limited to  $F_0$ : graph 1 points to a difference in vocal effort between the two reading conditions. This may shed some light on how listeners disentangle the various phenomena that compose prosody:  $F_0$  is one out of several correlates of tonal and intonational factors.  $F_0$  curves result from the interaction – some would say the superposition – of tones with the various intonational phenomena.

These facts are unlikely to surprise linguists who are familiar with the modifications undergone by phonemes in spontaneous speech: in this respect, tones are like phonemes.

#### 4 Discussion and conclusion: on the relationship between the tonal and intonational systems of a language

The two main points made above concern lexical tones and intonation, respectively: (i) not all lexical tones lend themselves to an analysis into levels; (ii) not all languages have tonal intonation.

These two observations may in fact be related: it is likely that there exists a correlation between the structure of a language’s lexical tone system and the tonal vs. non-tonal dominance of its intonation system. It is intuitively clear that multilevel tone systems, where tone sequences are highly complex (e.g. Ngamambo, Wobe: see [4] and references therein), cannot allow the type of intonational flexibility which is pervasive in Mandarin or Vietnamese, because such flexibility would obscure the utterance’s underlying tonal string. The considerable importance of lexical and morphosyntactic tonal calculations in multilevel tone systems may also explain the tendency for these systems to develop tonal intonation: a tonal reinterpretation of certain aspects of intonation can be considered as structurally economical in linguistic systems where the tonal string of utterances already carries a high functional load. Conversely, the conspicuous absence of any calculations over tone sequences in Vietnamese (which has neither tonal morphology nor categorical tone sandhi) may go a long way towards explaining why this language does not develop any tonal intonation.

The perspectives sketched out above have consequences for the analysis of intonation in non-tonal languages. They are hard to reconcile with autosegmental-metric models: the most extreme versions of these models postulate tonal intonation in all of the world's languages, whereas the present proposals amount to saying that tonal intonation is a special case, rather than the general rule.

It seems safe to conclude that the development of adequate models for prosody, in its full typological diversity, still remains a task for the future. This formidable challenge appears less intimidating if it is addressed from several complementary perspectives, including typological and comparative-diachronic approaches.

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