

A fresh look at the paradoxal nature of Chinese contour tones

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In the literature of tonology, it is generally assumed that contour tones are more marked than level tones, as they are more “complicated”, or more difficult to produce and perceive (Yip 2002, Zhang 2002). This hypothesis fails to explain why there are Chinese dialects with only contour tones, and why there is no tonal system having only level tones in Chinese dialects. On the basis of a universal tonal periodic skeleton HLHL postulated by Carvalho (2002), we propose a tonal representation capable of naturally accounting for the notion of tonal markedness, the interaction between contour and register, and diverse sandhi systems of Chinese dialects. By comparison with current models in which tonal markedness and licit contours are obtained by stipulation, the present framework yields a completely different picture of tonal markedness. It provides furthermore a unified explanation to the paradoxical nature of Chinese contour tones and offers a straightforward account of the concordant relationship between citation tones and sandhi behavior.

1. Introduction

Since the 1970s, the tonology has received a lot of attention in generative and post-generative phonology. From the theory of the tone feature system of Wang (1967) to the hypothesis of a dominance relationship between register and tone as suggested by Clements (1983), and the internal structures of the tone proposed by Yip (1980, 1989) and Hyman (1986), whose models are capable of explaining tonal behaviors in Chinese and African languages. For example, Yip (1989) posits that underlying tones include contours under a single Root Node encoding register in Chinese. By contrast, it is well admitted that, in African languages, underlying tones are all level tones, and contour tones are the result of associating two tonal Root Nodes to one tone-bearing unit. Assuming this representational difference, one typological problem remains. If contour tones are more marked than level tones, as they are more “complicated”, or more difficult to produce and perceive, why contour tones can be found on any syllable in Chinese whereas they can be found only under certain conditions in African languages? Why are there Chinese dialects which have only contour tones, such as in Chengtu, Shanghai, Zhenhai, Pingyao and Wuxi? Why is there no tonal system with only level tones in Chinese dialects?

Current tonal models consider the syllable to be a base occupying a portion of time. Tones are autosegments linked to this syllabic base through a tonal node (or a tonal root), and they are likely to spread and to be dissociated. However, in order to account for such typical features of Chinese tones as contour- and register-based oppositions, this view compels us to enrich tonal

representations both in terms of primitives and of their organization. Hence, for example, the nature of the nodes dominating [+/-upper] features remains obscure. Does the register imply a specific prime?

According to Cao (1985), there exists a fundamental difference between African tones and Chinese tones, with the latter not being a prosodic fact:

“...le ton du chinois et du vietnamien n’est pas un fait prosodique: il caractérise la syllabe au même titre que l’initiale et la rime...il n’y a pas de raison de placer le ton sur un étage autosegmental...comme toutes les autres unités linguistiques, les unités prosodiques ont leur place dans la hiérarchie du système et leur fonction. C’est en ignorant ce fait qu’on en est venu à se créer l’illusion d’une pluralité d’étages autonomes et segments indépendants les uns des autres, illusion qui à son tour donne naissance à des faux problèmes comme celui de tons flottants.”

[...tones in Chinese and in Vietnamese are not a prosodic fact: they characterize the syllable just as the initial and the rime...there is no reason to put the tone on an autosegmental tier...just as any other linguistic units, prosodic units have their own place in the hierarchy of the system and their function. It is by being unaware of this fact that we came to create the illusion of a plurality of autonomous tiers and independent segments one from the other, illusion which in its turn gives rise to false problems such as floating tones.]

However, a number of facts support Wang's (1967) assumption according to which the tone is located on a specific tier, tonal processes being largely independent of segmental features:

"the interaction of tones in a sequence is independent of the nature of the segments which occur with tones."

The goal of this research is to propose a tonal representation capable of accounting naturally for the notion of tonal markedness and diverse sandhi systems of Chinese dialects. We work under the assumption of a universal tonal periodic skeleton HLHL postulated by Carvalho (2002), analogous to the syllabic skeleton CVCV proposed by Lowenstamm (1996). According to this view, in Asian languages, syllables, not tones, look for a “skeletal” base, which is, thus, of a tonal nature. Based on the principles of government phonology, this model provides a straightforward formalization of two major characteristics of Asian tonal systems: the contour and the register.

2. Hypothesis of a tonal template

We conjecture that Chinese tones are constrained by a portion of a periodic HL skeleton: a tonal template HLHL. Following Clements (1983) and Kaye (2001) according to whom the register is the tonal head, we posit that Chinese contour tones can be analyzed as a succession of two level tones defined by an intratonal government relationship H/L encoding the notion of register, just as the vocalic aperture contrast /e/ : /ɛ/ has been said to involve an infra-segmental government relationship between primitive elements : /I > A/ versus /A > I/ respectively (Anderson & Ewen 1987, Kaye *et al* 1985). The four citation tones in Mandarin can thus be represented as follows (the vertical link indicates the tonal head). The register is low if and only if the head is low; it is high if and only if the head is high.

- (1) a. $\begin{array}{cccc} \mathbf{H} & \mathbf{L} & \mathbf{H} & \mathbf{L} \\ | & & / & \\ \sigma & & & \end{array}$ Tone 1 : level tone (55)
- b. $\begin{array}{cccc} \mathbf{H} & \mathbf{L} & \mathbf{H} & \mathbf{L} \\ & \backslash & | & \\ & & \sigma & \end{array}$ Tone 2 : rising tone (35)
- c. $\begin{array}{cccc} \mathbf{H} & \mathbf{L} & \mathbf{H} & \mathbf{L} \\ \backslash & / & & \\ & \sigma & & \end{array}$ Tone 3 : falling-rising tone (21[4])
- d. $\begin{array}{cccc} \mathbf{H} & \mathbf{L} & [\mathbf{H} & \mathbf{L}] \\ / & & & \\ \sigma & & & \end{array}$ Tone 4 : falling tone (51)

The representations in (1a-d) imply that the level tone in (1a) is not intrinsically shorter than the other three tones, especially the contour tone HL in (1d), which only involves a small portion of the tonal template. The level tone constitutes a contour just as a long vowel or a geminate consonant, associated to two skeletal positions. Indeed, according to the phonetic studies of Kratochvil (1968) and Xu (2004), tone 1 is longer (and, in any case, is not shorter) than tone 4 when pronounced in isolation, as is shown in figure (1), drawn from Xu (2004):

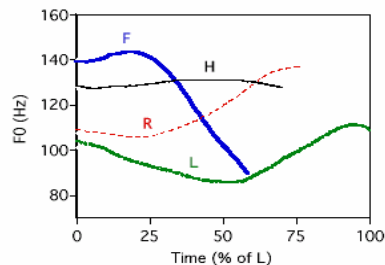


Figure (1): Mandarin four tones pronounced in isolation

If the analogy syllable/tone is on the right lines, it follows from (1a-d) that tonal markedness can be deduced from the hypothesis of a tonal skeleton within a 'strict HL' approach:

- (2) a. *Just as CV is unmarked compared with .VC. within a 'strict CV' approach, the falling tone HL is unmarked by comparison with the rising tone LH, because the latter one supposes two empty positions on its right and left sides.*
- b. *Just as geminate consonants (CC) are marked compared with CV, level tones are more marked than contour tones since their lexical representations involve not only two empty tones just as the rising tone, but also a median empty tone.*

Regarding level tones, we suppose that they are more marked than contour tones since their lexical representations involve not only two empty tones, but also a *median* empty tone. In other words, there are two successive empty L (or H) tones, which would also be difficult for two successive empty nuclei, as in *[rvny] in French. Even assuming that they involve one single HL

base, level tones are more marked than falling tones, in so far as they imply an empty skeletal position: H(B) or (H)B. Consequently, their existence should imply the presence of contour tones, but the opposite is false.

If the nucleus is said to be the sonority peak since Sievers (1876) and Jespersen (1912), we might ask what the tonality peak is in the tonal domain. From an acoustic point of view, the high tone is more prominent than the low one (de Lacy 2002). Let us hypothesize that it has the same status as the nucleus. Consequently, just as V is structurally unmarked compared with C, H should be unmarked by comparison with L. The existence of low tones, structurally marked, should imply the presence of high tones.

If, in the domain of syllables, all government relations are ultimately derived from the nucleus, we might expect that the high tone plays the same role in Asian tonal languages. Remind that the nucleus governs the onset, and, in the case of branching onsets, it licenses the non-head segment to govern its complement. For example, in French *patrie*, /i/ licenses the less sonorant consonant /t/ to govern the more sonorant consonant /r/ (see Charette 1990). Assuming the parallel syllable/tone, H should license L so that the latter one has the possibility to govern. This conjecture has an empirical consequence: it implies that, in a right-dominant tonal language where there is a sequence of two successive L tones, the intertonal government relationship cannot be derived legally since there is no high tone licenser. The only way to authorize the intertonal government relationship is to insert an epenthetic H tone licensing L₂ so that the latter one can play its role of governor. As we will see in §4.3, this is exactly what happens in Tianjin, where L₁+L₂ gives L₁H.L₂.

We assume furthermore the following locality constraint:

- (3) *In lexical tones, a governed position is adjacent to its head.*

It follows from this constraint that *HLHL and *LHLH are naturally excluded, since they would automatically violate the locality constraint in (3). (4b) also violates a strict HLHL template.

- (4) a. *HLHL
 H L H L
 \ / / \
 σ
- b. *LHLH
 H L H L [H L]
 \ / / \
 σ

Within current models, tonal markedness and licit contours are obtained by stipulation. Thus, Yip (1980) postulates that "*the maximum number of tone feature occurrences in sequences is three.*" OCP has also been invoked to explain the nonexistence of citation tones *[HL][HL] and *[LH][LH] (Yip 1989). In our model, however, neither stipulations nor OCP are necessary for avoiding overgeneration.

3. Arguments for the existence of a tonal skeleton

Having deduced the tonal markedness and excluded impossible tones in Chinese from the assumption of a tonal skeleton, the issue is whether there exists such a tonal skeleton, or it is only an artifact of the theory. It will be shown that arguments from typology, word games, and language acquisition provide strong evidence in favor of its existence.

3.1 Typological argument

In a statistics on 187 tonal languages, Zhang (2002) noticed that 37 languages have a falling tone without a rising one. Only three languages have a rising tone without a falling one: Margi, Lealao Chinantec and Zengcheng. That level tones are marked vis-à-vis contour tones is also supported by empirical facts, since a language can have only contour tones without level tones, as in Chengtu, Shanghai, Zhenhai, Pingyao and Wuxi.

The unmarkedness of the high level tone compared with the low level tone is supported by the typology: in Contanese, Tianjin, and Taiwanese, the low level tone and the high level tone coexist; Mandarin has only the high level tone without its low counterpart. Chen (2000) also notices that, if a language has one level tone, it is almost invariably the high one.

3.2 Language acquisition

Evidence of the unmarked nature of H can also be found in language acquisition. In a study about a Cantonese speaking child from 0;6 to 2;6, J. Tse (1978) observes that the low rising contour (13) is more difficult for child than the high rising contour (35). A. Tse (1992) also notices that the three tones of the high register (55, 35, 33) are mastered earlier than those of the low register (22, 13, 21). These studies confirm the primitive character of the H register since it is acquired earlier by children. In a study about two Mandarin speaking children from 1;10 to 2;10, Clumeck (1980) confirms this order of acquisition : the high level tone is pronounced with an accuracy rate of 97.2%, followed by the falling contour (95.8%), the falling-rising contour (73.9%), and the rising contour (61.3%).

The marked status of the rising tone compared with the falling contour is supported by A. Tse's study: the low falling tone is acquired by 2;9, whereas the low rising tone is learned by 3 years old.

3.3 *Fanqie* languages

Fanqie ("reverse cut") was a traditional philological method used to specify the pronunciation of a new character in terms of two known words. According to Bao (1990, 1999), the following tone patterns are observed in *fanqie* languages, based on different dialects:

- (5) a. May-ka: new rime on σ_1 ; source tone on σ_2 , new tone on σ_1 .
 ma 55 > may 15-ka **55**
 pəɲ 15 > pay 15-kəɲ **15**

- b. Mo-pa: new rime on σ_1 ; source tone on both σ_1 and σ_2 .
 pã 33 > p_Q 33-vã 33
 ts^h_I 4 > ts^h_Q 4-zI 4
- c. Man-t'a: new coda on σ_1 ; source tone on both σ_1 and σ_2 .
 ma 55 > man 55-t^ha 55
 taw 51 > tan 51-taw 51
- d. La-pi: new nucleus on σ_2 ; source tone on both σ_1 and σ_2 .
 t^hat 31 > lat 31-t^hit 31
 hyaw 53 > lyaw 53-hi 53

We notice a double asymmetry in *fanqie* languages. First, the second syllable always retains the source tone. The following form is not attested in the literature on *fanqie* languages.

- (6) t^haw 13 > *law 13 t^hi 31

Secondly, the replacement of the source tone on the first syllable implies that of the rime (cf. 7a), but the substitution of the rime doesn't trigger that of the source tone (cf. 7b). The rime can't be retained on σ_1 if the source tone is replaced (cf. 7c).

- (7) a. pən 15 > pey 51-kən 15 (new rime, new tone)
 b. pã 33 > p_Q 33-vã 33 (new rime, source tone)
 c. hyaw 53 > *lyaw 13-hi 53 (source rime, new tone)

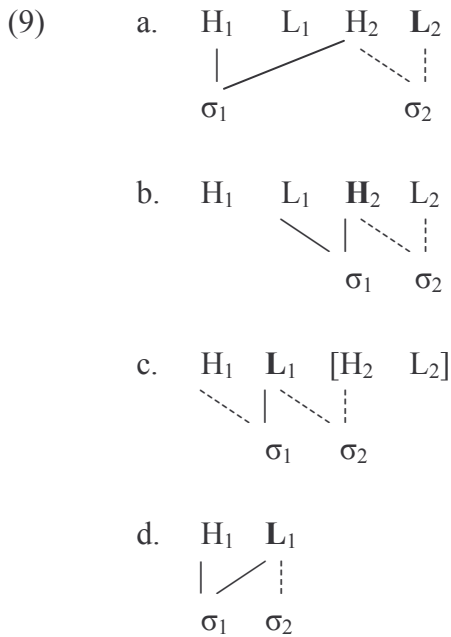
From the perspective of a framework which assumes the skeletal nature of tones, these remarks are highly significant: in any case, tones may be stable (and reduplicated) under the substitution of the rime, the nucleus and the coda. It is well admitted that reduplication primarily acts on skeletal units, which encode phonological length (cf. Mokilese *sɔɔrok* → *sɔɔ-sɔɔrok*). Now, reduplication may involve tones but not segments. Therefore, tones dominate syllables (which dominate segmental primes), and form, thus, the skeleton of phonological representations.

3.4 Empty tonal positions

In Mandarin, grammatical morphemes (particles, classifiers) are conveyed by syllables that carry the so-called 'light tone'. These syllables, which follow those bearing one of the four lexical tones, are characterized by a shorter duration, and have no lexical tone. According to Shih's (1987) phonetic analysis, such toneless syllables are realized as follows:

- | | | |
|-----|----------------|-----------------------------------------------------|
| (8) | Preceding tone | Toneless syllable |
| | 55 H | starts high, then falls |
| | 35 LH | starts high, then falls, but not as low as after 55 |
| | 21(4) HL(H) | starts fairly low, then rises |
| | 53 HL | starts fairly low, and falls even lower |

Within the present framework, we suppose that the toneless syllable associates to the last full tone of the first syllable and to the following empty tonal position, if any:



This hypothesis predicts correctly the register of the light tone preceded by the four lexical tones: in Shih's phonetic analysis, the light tone is realized as a falling tone when it is preceded by tone 1 or tone 2, but it has a low register when it is preceded by tone 1. The light tone is realized as a rising tone with a low register after tone 3. When preceded by tone 4, it has a low register. The intratonal government encoding the notion of the register accounts for the realization of the light tone naturally: in (9a, c, d), the light tone has a low head whereas it has a high head in (9b).

4. A unified explanation to tone sandhi in Mandarin and in Tianjin

4.1 Mandarin Tone Sandhi

Remind that there are four lexical tones in Mandarin, namely 55 (H), 35 (LH), 214 (HLH), and 51 (HL). There is a concave tone HLH (214) in Mandarin, but not, e.g., in Tianjin. Moreover, Mandarin is known to be a right-dominant language (Chao 1968, Yip 1980, Lin 1983, Hashimoto 1987), where the pretonic syllable, being unstressed and relatively short, is not capable of bearing the concave tone HLH. These facts can be captured by the following constraints:

- (10) a. Templatic constraints:
- i) $M \leq S + 1$: the number of modulations cannot be superior to the number of syllables + 1;
 - ii) $M\sigma_1 \leq 1$: no more than one modulation in the pretonic syllable.
- b. Intertonal government:
The head of the governing syllable governs its melodic counterpart in the governed syllable. The direction of intertonal government goes from right to left.
- c. Proper government:
A position is *properly* governed by the head of the governing syllable iff the templatic constraints in (a) are violated. The properly governed position is *empty*.

The famous ‘‘T3 sandhi’’ can be given the following unitary account:

- (11) a. $214+55 \rightarrow 21.55$
-
- b. $214+51 \rightarrow 21.51$
-
- c. $214+35 \rightarrow 21.35$
-
- d. $214+214 \rightarrow 35.214$
-

In (11d), just as in French schwa/zero alternations, where an empty nucleus is phonetically realized when it is not properly governed (i.e. *revenu* [rɛvny]), we suppose that H_2 , not properly governed, must be realized phonetically. Hence, it governs H_1 that is lexically empty, and L_1 becomes an intratonal governed position, which involves register change. Thus, T3-sandhi supports our conjecture that the register is the tonal head.

4.2 Tianjin tone sandhi

According to Shi (1990), the tone digits of the four citation tones in Tianjin are 11 (L), 55 (H), 24 (LH) and 53 (HL). The head of contour tones in Tianjin are at left, since LH and HL have, respectively, L and H registers. The Tianjin sandhi rules are given in (12) (Yip 1989, Chen 2000):

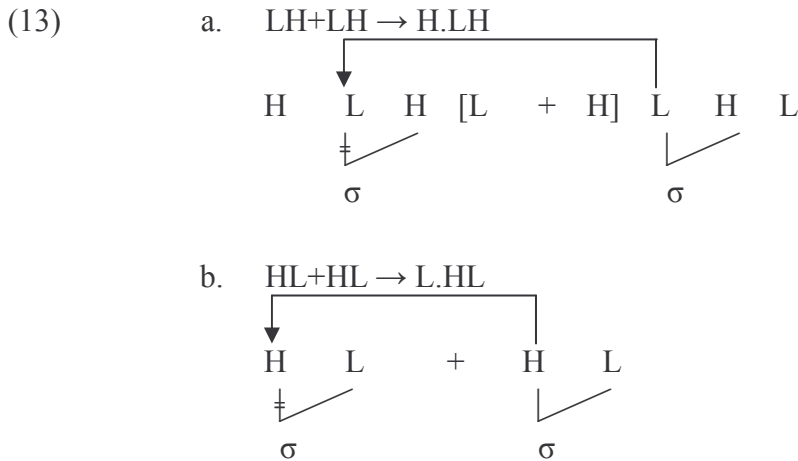
- (12) Tonal dissimilation:
- $L+L \rightarrow LH.L$
 - $LH+LH \rightarrow H.LH$
 - $HL+HL \rightarrow L.HL$

In addition, $L+L$ gives $H.L$ among young speakers (Wee 2004).

Based on Optimality Theory, Yip (2002) and Chen (2002), among others, posit that Tianjin tone sandhi is triggered by the Obligatory Contour Principle (OCP), banning two adjacent identical contours or tonal segments. However, we don't understand why HL.HL, LH.LH and LH.HL are not subject to tone sandhi in Mandarin, if the OCP is a universal principal rather than

a violable constraint. Now, there is a concordance between the number of modulations on lexical tones and the number of modulations on disyllable words in Tianjin as well as in Mandarin.

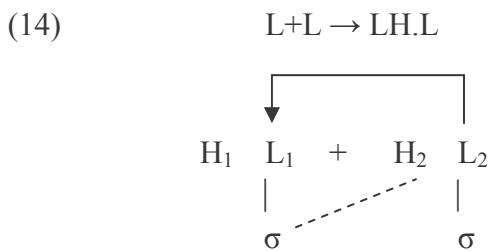
As there are neither concave nor convex citation tones in Tianjin, we suppose that *the number of modulations should be equal to that of syllables* in this dialect. In (13b) and (13c), there are three underlying modulations on two syllables, which triggers the tone sandhi. Consequently, the governed head of the first syllable becomes empty, as is shown in (13):



4.3 Tonal epenthesis in Tianjin

Why is there tone sandhi in the sequence L+L in Tianjin, which does not violate the templatic constraints? Why is there no tone sandhi in the sequence H+H, leading Yip (1989) to hypothesize that H is the unmarked tone?

As is shown in §2, we hypothesize that all government relations are ultimately derived from the high level tone in the tonal domains. H should license L so that the latter one has the possibility to govern. Consequently, in a right-dominant tonal language where there is a sequence of two successive L tones, the only way to authorize the intertonal government relationship is to insert an epenthetic H tone licensing L_2 so that H can play its role of governor. This is exactly what happens in Tianjin, where L_1+L_2 gives $L_1H.L_2$ ¹



This explains at the same time the tonal stability in H_1+H_2 and L_1+L_2H . In the first case, H_2 is itself the licenser; hence it can govern its melodic counterpart. In the second case, H licenses L_2 , so that it can govern L_1 ². Consequently, the reason why there is tone sandhi in the Tianjin

¹ In the Mandarin sequences HLH+H, HLH+HL and HLH+LH, the licenser coincides with the intratonal governing head (cf. §4.1). In the sequence HLH+HLH, the intratonal L head of the stressed syllable receives its licence to govern from the preceding H tone so that L can assume its role of governor (cf. §4.1).

² Notice that there is no deletion of the governed tone here since templatic constraints are not violated.

sequence L+L, whereas tones remain stable in the sequence H₁+H₂ of Tianjin and Mandarin, is now evident: it is the necessity for an intratonal L head to be licensed to govern by the H tone.

Ancient Chinese confirms the unmarked nature of H: the H register appeared always with voiceless onsets, and the L register appeared with the voiced ones. Voiceless consonants are known to be unmarked vis-à-vis voiced and aspirated ones³. This leads us to assume that unmarked consonants occur only with the unmarked register.

The last argument, although indirect, of the primitive character of the H register comes from some Mandarin dialects spoken in the northwest of China. In Shang, the tone is used to mark the pronominal plurality (Yuan *et al.* 1960, Zhan 1981):

- (15) a. ɲɤ 53/21 "I/we"
 b. ni 53/21 "you (sg.)/you (pl.)"
 c. t^ha 53/21 "he, she, it /they "

The singular pronouns all have the high falling tone 53, and their counterparts have the low falling contour 21. In other words, the number distinction can be reduced to register only: H marks singular, and L plural. The singular being *an atom* vis-à-vis the plural in the sense of Chierchia (1998), it seems that speakers choose an unmarked register to express a primitive category.

Given the templatic constraint and the elision, we are now in a position to explain the different sandhi behavior between Mandarin and Tianjin: contrary to what happens in Tianjin, there is no tone sandhi in Mandarin in sequences such as HL+HL or LH+LH because Mandarin and Tianjin have different templatic constraints: there can be three modulations on two syllables in Mandarin, not in Tianjin. The conditions required by elision explain why there is no tone sandhi in the Mandarin sequence LH+HL, while the same sequence undergoes sandhi in Tianjin: only the tail can be elided, not the head; now, the head of LH is L in Tianjin, but H in Mandarin.

4.4 Tonal absorption in Tianjin

Apart from tonal dissimilation rules, there are also three tonal absorption rules, as are reported by Yip (1989) and Wee (2004). The three tonal absorption rules are given as follows:

- (16) a. HL+L->H.L
 b. LH+H->L.H
 c. LH+HL->L.HL

One might ask why there is tone sandhi in these cases, as the templatic constraints are not violated. We suggest that there is *elision*: just as in the case of French *liaison*, where “la + amie” gives “l’amie”, so does the tonal tail of the first syllable fall if (a) it has the same height as the head of the second syllable, (b) both tones are adjacent.

Note that the elision occurs only when the tail of the first syllable and the head of the second syllable are adjacent and homorganic. That’s why, in Mandarin, the sequence LH+HL does not undergo tone sandhi, while it does in Tianjin: only the tail can be elided, not the head, and Mandarin has LH versus LH in Tianjin. Elision is thus the second reason for the dissociation

³ All languages have at least a contrast between a voiceless consonant and another glottal state (aspirated, voiced, and/or glottalized). This seems to confirm the pivot role of the voiceless consonants. See Carvalho (2002).

of a governed position.

4.5 The nature of the tonal skeleton

From the assumption of the tonal skeleton, a basic question follows : what is the nature of these tonal positions ? We consider that they are similar to the moras, which encode both timing and weight.

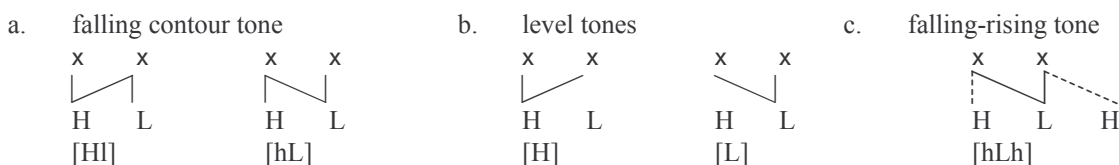
Duanmu (1994) uses moras to explain the sandhi difference between Mandarin and Shanghai: Mandarin being a bimoraic language, every syllable is capable of carrying contour tones; Shanghai is a monomoraic language, so the syllable is not capable of bearing contour tones. For Duanmu, the function of the mora consists of explaining the capacity or incapacity of carrying a contour tone. However, there is no vowel length contrast in Chinese: the mora may be substantively grounded in Duanmu's conjecture, if contour tones do involve longer vowels; it remains that it has no independent phonemic motivation. This postulation is, as it stands, circular. If we assume that every minimal word is composed of two moras, a new problem arises: if the coda is not moraic, we don't understand why, in open syllables, the vowel doesn't lengthen; if the coda is moraic, we can't explain why it doesn't bear a tone in certain circumstances.

In the line of *phonetically-based phonology* (Steriade & Hayes 2004), Zhang (2001) argues that contour tones need ample duration to be realized, because the muscle contraction that is necessary for an articulatory movement needs time to be implemented. Thus, they are more marked than level tones. He also finds that the distribution of contour tones in a language is closely correlated with the duration of the sonorous portion of the rime. Syllable types which have longer sonorous duration of the rime, e.g. long-vowelled, sonorant-closed, stressed, final in a prosodic position, and in a shorter word, are more likely to carry contour tones. This approach incurs a simple criticism: while it may achieve observational adequacy, it fails to encode the observed preferences directly in phonological representations. Furthermore, admitting that there is a close relationship between the presence of contour tones and vowel length, why is it that, in right-dominant languages such as Mandarin and Tianjin, putatively marked contour tones can subsist and even emerge in pretonic position? In Tianjin for example, L+L gives LH.L. If tone sandhi was due to the OCP, banning two adjacent identical objects, why wouldn't we have *H.L or *L.HL in the surface form, which respect positional markedness?

Given the inadequacy of both Duanmu's moraic hypothesis, and phonetically-based explanations, we will make the following claim. If complex tones, and only tones, do require length, they should be viewed as being directly associated to the skeletal units encoding length in autosegmental theories. As will be seen, examples of tone sandhi in Tianjin provide strong evidence in favor of this assumption.

There are no obstruent-closed syllables in Tianjin, which is shared by most northern dialects; hence, all syllables are underlyingly bimoraic as represented in (17), where *the head will be assumed to be associated to both moras*⁴. One sandhi rule in Tianjin is HL+HL→L.HL.

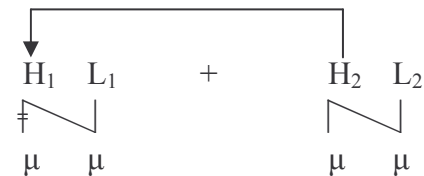
⁴ The representations in (16) are a slightly revised version of those in (1). Following Carvalho (2002a, b) who uses the same device to represent VOT, we suggest that the tonal head can also be represented by the spreading of a tonal segment to an adjacent position (the capital letter indicates the the tonal head):



Intertonal government applies in (17a) because of the violation of the templatic constraint. L+HL, however, remains unchanged:

(17)

a. HL+HL→L.HL



b. L+HL→L.HL



It follows that the L tone derived from HL in (16a) should be shorter than the lexical L tone in (17b), since intertonal government causes dissociation of H₁. Besides, the initial part of the derived L tone should be raised by the head H₁. This conjecture is confirmed by phonetic data (Wee 2004): the derived L tone in Fig. 2 is both slightly falling and much shorter than its lexical counterpart in Fig. 3:

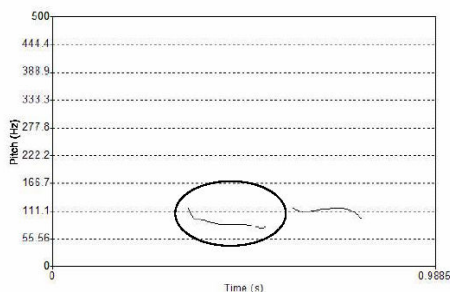


Figure 2: L derived from the sequence HL+HL → L.HL

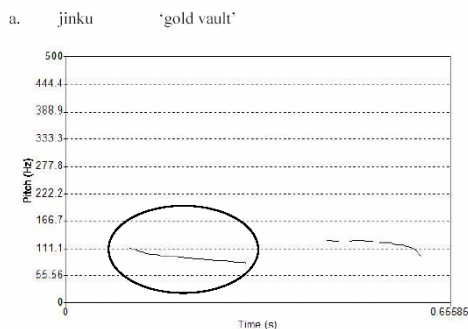


Figure 3: Lexical L tone

How to explain that, in the same context, the non derived L tone is longer than the L tone derived from /HL/? The only explanation is that, in /HL/, it is H which is associated to two positions and it is H the target of tone sandhi. On the contrary, in /L/, the tone is associated to two positions and is not affected by the /HL/ on its right side.

In (a), there is a perfect mapping between the tonal skeleton and the temporal skeleton, hence the unmarked nature of the falling tone. In this sense, in (c), HLH is marked in that there are three tonal segments against two skeletal positions, just as an branching onset is necessary marked compared to an simple onset. It follow that the relation between HL and pure positions are the same as that between ON and pure positions: just as the unmarkedness of ON implies the biunivocity in so fas as one position corresponds to a syllabic element (onset or nucleus) and vice-versa, now, if ONON constitutes a skeleton, HLHL does, too.

5. Conclusion

One might ask why the order of the tonal skeleton should be HLHL..., rather than *LHLH...? The first argument comes from Chengtu, a Mandarin dialect spoken in the Province of Szechuan: when the low falling tone is preceded by other tones, it is realized in [LH]. However, there is an initial epenthetic H tone when the low falling tone is in the initial position, giving [HLH]. This comes in support of the conjecture that there exists a periodic tonal skeleton and that its order is HLHL rather than *LHLH.

The second justification comes from the majority realization of the light tone in falling contour in Mandarin, where there seems to be a final L tone (cf. §3.4). Duanmu (1994) posits as well a domain-final effect when treating the sandhi data of Wuxi and Old Shanghai, where in a disyllabic (or longer) domain, the final syllable receives an additional L. This final L insertion can be accounted for in the present model, and there is no need to postulate an independent rule.

The hypothesis of a periodic tonal skeleton in which contour and register are represented through the same primes enables us to explain: (a) why there are Chinese dialects having only contour tones; (b) why there is no tonal system with only level tones in Chinese dialects. There is no need to posit register primitives, such as [+upper] or [-upper], since the register is incorporated into the tonal representation: it is the tonal head. More generally, it provides a simple and unified account of tone structure and markedness, which is supported by such diverse aspects as typology, language acquisition, word games (*Fanqie*), and the realization of toneless syllables ('light tone'). Furthermore, the present analysis sheds light on the relationship between the representation of tones and their behavior vis-à-vis sandhi. The sandhi-related differences among dialects are indeed due to different templatic constraints on the tonal system, as well as to representational differences between tones. Finally, examples from Tianjin sandhi provide evidence for a direct interaction between moraic and tonal positions, supporting the idea that, contrary to what follows from current models, Chinese tones do have a 'skeletal' character, and might constitute the basis to which syllables are associated.

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References

- Anderson & Ewen (1987). *Principles of Dependency Phonology*, Cambridge University Press, Cambridge.
 Bao, Z. (1990). *On the Nature of Tone*. Doctoral dissertation, MIT.
 Bao, Z. (1999). *The Structure of Tone*, Cambridge University Press, Cambridge.
 Broselow, E. (1995). Skeletal positions and moras. J. Goldsmith (ed.). *Handbook of Phonological Theory*. Blackwell Publishers, Oxford, pp. 175-205.

- Cao, X. H. (1985). *Phonologie et linéarité: Réflexions critiques sur les postulats de la phonologie contemporaine*. SELAF, Paris.
- Carvalho, J. Brandão de (2002a). *De la syllabation en termes de contour CV*, Habilitation thesis, Ecole des Hautes Etudes en Sciences Sociales, Paris.
- Carvalho, J. Brandão de (2002b). What are phonological syllables made of? The voice/length symmetry. In Jacques Durand & Bernard Laks (eds.), *Phonetics, Phonology, and Cognition*. Oxford University Press, Oxford, pp. 51-79
- Chen, M. (2000). *Tone Sandhi*, Cambridge University Press, Cambridge.
- Chang, N. C. (1958). Tone and Intonation in Chengtu Dialect. Dwight Bolinger (ed.), *Intonation*. Penguin Books Ltd., Middlesex, pp. 391-413
- Chao, Y. R. (1968). *A grammar of Spoken Chinese*. University of California Press, Berkeley and Los Angeles.
- Chierchia, G. (1998). Plurality of mass nouns and the notion of semantic parameter. S. Rothstein (ed.), *Events and Grammar* 70, pp. 53-103
- Clements, Georges N. (1983). The Hierarchical Representation of Tone Features. Ivan R. Dihoff (ed.), *Current Approaches to African Linguistics*, vol. 1, Dordrecht, Foris.
- Clements, Georges N. (1985). The geometry of phonological features. *Phonology Yearbook* 2, pp.225-252.
- Clumeck, H. (1980). The acquisition of tone. Yeni-Komshian, Kavanagh & Ferguson (eds.), *Child Phonology I: Production*. NY Academic Press, New York, pp. 257-275
- de Lacy, P. (2002) : *The formal expression of markedness*. PhD dissertation, University of Massachusetts, Amherst.
- Duanmu, S. (1990). *A formal study of syllable, tone, stress, and domain in Chinese languages*, Doctoral dissertation, MIT.
- Duanmu, S. (1994). Against Contour Tone Units, *Linguistic Inquiry*, 25:4, pp.555-608
- Hashimoto, Yue (1987). Tone sandhi across Chinese dialects. In *The Wang Li Memorial Volumes*, pp. 445-474.
- Hayes, B. (1989). Compensatory lengthening in moraic phonology. *Linguistic Inquiry* 20, pp. 253-306
- Hyman, L. & Schuh, (1974). Universals of tone rules: Evidence from West Africa. *Linguistic Inquiry* 1, pp. 81-115
- Hyman, L. (1986). The representation of multiple heights. Bogers, van der Hulst, and Mous (eds.) *The Phonological Representation of Suprasegmentals*. Dordrecht, Foris.
- Hyman, L. (1993). Register tone and tonal geometry. Hulst and Snider (eds.), *The Phonology of Tone: the representation of Tonal Register*. Mouton de Gruyter, Berlin and New York.
- Jespersen, O. (1912). *Lehrbuch der Phonetik*. Teubne, Leipzig and Berlin.
- Kaye, J., Lowenstamm, J. & Vergnaud, J.-R. (1985). The internal Structure of phonological elements: a theory of charm and government. *Phonology Yearbook* 2, pp. 305-328.
- Kaye, J. (2001). *A Short Theory about Tones*. Ms., Guangdong University.
- Kratochvil, P. (1968). Tone in Chinese. Erik C. Fudge (eds), *Phonology*, Penguin Books, pp. 342-353.
- Li, C. N. & Thompson A.. (1977). The acquisition of tone in Mandarin-speaking children. *Journal of Child Languages* 4.2, pp. 185-199.
- Lin, M. C. (1983). The stress pattern and its acoustic correlates in Beijing Mandarin. *Proceedings of the Tenth International Congress of Phonetic Sciences*, pp. 504-514.
- Liu, T. H. (2005). *Gouvernement, tons modulés, et sandhi tonal*. Master thesis, Université de Paris 8, Paris.
- Liu, T. H.. (2006). *Registre, Contour, and Markedness in Chinese*, ms., Paris.
- Liu, T. H. (2007). *Rudplication as Evidence for the Skeletal Nature of Tones*. Poster presented at the Fifteenth Manchester Phonology Meeting, Manchester, May 24-26
- Lowenstamm, J. (1996). CV as the Only Syllable Type. Jacques Durand & Bernard Laks (eds.), *Current Trends in Phonology: Models and Methods*, CNRS, Paris X : ESRI, vol. 2, pp. 419-441.
- Martinet, A. (1974). *La linguistique synchronique*. Presses Universitaires de France, Paris.
- McCarthy, J. & Prince, A. (1986). *Prosodic morphology*. Ms., University of Massachusetts and Brandeis University.
- Prince, A. (1992). Quantitative consequences of rhythmic organization. *CLS 26*. Papers from the 26th Regional Meeting of the Chicago Linguistic Society Volume 2 : *The Parasession on the Syllable in Phonetics and Phonology*, Chicago Linguistics Society, pp. 355-398

- Rialland, A. (1991). L'allongement compensatoire: nature et modèle. B. Laks & A. Rialland (eds.), *Architecture des représentations phonologiques*. Presse du CNRS.
- Shih, C. (1987). The phonetics of the Chinese tonal system. *Technical memorandum*, AT&T Laboratories.
- Shi, F. (1990). *Hanyu he Dong-Tai yu de Shengdiao Geju [Tone Paradigms in Chinese and Kam-Tai languages]*. Doctoral dissertation, Nankai University.
- Sievers, E. (1876). *Grundzüge der Lautphysiologie zur Einführung in das Studium der Lautlehre indogermanischen Sprachen*. Beitkopf und Härtel, Leipzig.
- Steriade D. et Hayes B. (2004): The phonetic basis of phonological markedness. D. Steriade, R. Kircher & B. Hayes (eds.), *Phonetically-Based Phonology*. Cambridge University Press, Cambridge.
- Tse, K. P. (1978). Tone acquisition in Cantonese : a longitudinal case study, *Journal of Child Language* 5, pp. 191-204.
- Tse, C. Y. (1992). *The Acquisition of Cantonese Phonology - A case Study*, M. Phil. Thesis, University of Hong Kong.
- Yuan, J. J. et al. (1960). *Hanyu fangyan gaiyao (Introduction aux dialectes chinois)*. Hubei People's Press, Wuhan.
- Wang, S. Y. (1967). Phonological features of tone. *International Journal of American Linguistics* 33, pp. 93-105.
- Wee, L. H. (2004). *Inter-tier Correspondance Theory*. Doctoral dissertation, State University of New Jersey, Rutgers.
- Xu, Y. (2004). Understanding Tone from the Perspective of Production and Perception. *Language and Linguistics*. Academic Sinica, Taipei.
- Yip, M. (1980). *The Tonal Phonology of Chinese*, Doctoral dissertation. MIT.
- Yip, M. (1989). Contour Tones, *Phonology* 6, pp. 149-174.
- Yip, M. (2002). *Tone*, Cambridge University Press, Cambridge.
- Woo, N. H. (1969). *Prosody and Phonology*. Doctoral dissertation, MIT.
- Zhan, B. (1981). *Xiandai Hanyu fangyan (Modern Chinese Dialects)*. Hubei People's Press, Wuhan.
- Zhang, J. (2002). The effects of duration and sonority on contour tone distribution, New York. Routledge.