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REVIEW ARTICLE

Tone, accent and stress in Chinese[1]

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Matthew Y. Chen, *Tone sandhi: patterns across Chinese dialects.* Cambridge: Cambridge University Press, 2000. Pp. xx + 554.

Since Pike (1948), the world's extant tone languages are often classified into two types: terraced-level tone systems, typical of African languages, and contour tone systems, typical of Asian languages. While it no doubt obscures the tonological diversity within each system, the Africanist-Asianist dichotomy is nevertheless descriptively convenient. For some reason, students of nonlinear phonology rely heavily on tonal phenomena of African languages. In post-SPE generative phonology, it is the tonological behavior of these languages that ultimately liberates tone and, subsequently, other phonological features, from the confines of the simultaneous bundle, a notion that is central to the segmentalism of SPE representation (cf. Chomsky & Halle 1968). In the literature of nonlinear phonology, tonal phenomena of Asian languages play a supporting role – they are typically used to argue either for or against the universality of tonological processes found in African languages.

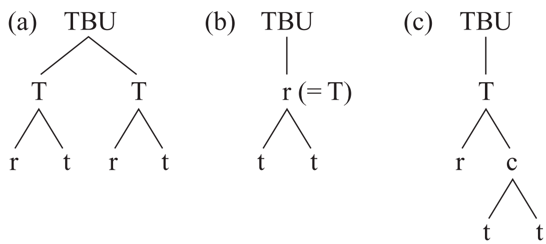
Against this backdrop, Chen's book is a welcome addition to tonological scholarship in general, and to Chinese tonology in particular. The book is large in scope. It has eleven chapters, a brief concluding section and a comprehensive bibliography of scholarly works on Chinese tone. Chapter 1 outlines the synchronic and diachronic properties of tone and tone sandhi in Chinese, and explains the traditional nomenclature, such as the tonal categories PING 'level', SHANG 'rising', QU 'departing' and RU 'entering', and the registers YIN (high) and YANG (low). Readers who are not familiar with Chinese and Chinese linguistics will find the chapter informative. The remaining chapters deal with the central leitmotifs of Chinese tonology: the internal structure of tone (chapter 2), the mechanism of tone sandhi (chapters 3

[1] This review article benefited from the encouragement of Matthew Chen, who read an earlier draft, and from discussions with Xu Liejiong and Eric Zee on nuances of the Shanghai dialect, and with Arto Anttila and K. P. Mohanan on issues in Optimality Theory. The comments of two anonymous *JL* referees are gratefully acknowledged. Of course, I am responsible for errors of fact and interpretation that still remain.

and 4), tone and accent (chapters 5 and 6) and tone sandhi domain (chapters 7 through 11). This review is structured around these themes.

1. Internal structure of tone

Tone as an autosegment has ample empirical support and is a well-established tenet of post-SPE generative phonology. The internal structure of tone, however, is controversial. In the Africanist literature, this is an issue of peripheral interest. Tonal contour is derived through the concatenation of atomic tones (or features) with different pitch. Thus, H (high) and L (low) realized on the same tone-bearing unit produce the falling contour. In Asian tone languages, tonal contour proves to be an intractable problem. While pitch movement (contour) and pitch height (register) are part of the descriptive vocabulary in traditional Chinese linguistics and generative phonology, their theoretical and representational status has generated heated debate. Although the theoretical tenor of the debate has changed along with the development of generative phonology, from the SPE-style feature bundle of Wang (1967) to the feature geometry of Yip (1989) and Bao (1990, 1999b), the core of the controversy remains the same: is pitch contour of a tone reducible to pitch height? Chen considers three models of tone that attempt to address this issue. They are displayed in (1) (TBU = tone-bearing units, T = tone root, r = register, c = contour, t = terminal tone segment definable with features such as [upper] and [raised]).

(1)


Tonal contour is represented as the concatenation of tone roots in (1a), the daughter of register in (1b) and the sister of register in (1c). In Chinese linguistics, (1a) is proposed by Duanmu (1990), (1b) by Yip (1989), and (1c) by Bao (1990, 1999b). Similar structures have been proposed in the broader literature; see contributions in Hulst & Snider (1993) and references cited therein.

The issue, of course, is an empirical one. While there is ample evidence suggesting that contour tones behave like single units, contrary to the predictions of the Africanist structure (1a),[2] there is far less unequivocal evidence

[2] The relevant tone sandhi evidence can be found in chapter 2. See also Yip (1980, 1989), Bao (1990, 1999b), Duanmu (1990), among others. Recent studies of Mandarin speech errors also support contour tones as single units (cf. Wan & Jaeger 1998; Wan 1999).

that differentiates between (1b) and (1c). The crucial difference between the two structures concerns the assimilatory behavior of tonal contour: (1c), but not (1b), predicts that register and contour may undergo independent assimilatory spread. Chen cites data from two dialects that support (1c).

Zhenhai, a Wu dialect, provides the relevant tone sandhi data that show that tonal contour spreads independently of register. The disyllabic tone melodies shown in (2) offer a critical piece of evidence ((68); cf. Rose 1990).[3]

(2) (a) 213-441→11-334
    (b) 213-231→11-24

441/231 and 334/24 represent high/low falling and rising tones, respectively. What is of interest here is that the rising contour of the first tone spreads to the second, displacing its original falling contour, while keeping its register. The first syllable loses its contour, and assumes the default tone 11. Contour spread supports (1c).

Chaozhou, a Southern Min dialect, furnishes evidence for independent register spread, which is displayed in the following sandhi patterns ((74); cf. Cai 1991; Bao 1999a):

(3) (a) LM-H→HM-H
    (b) LM-L→ML-L

The low rising tone becomes a high-fall when followed by a high tone, (3a), but a low-fall when followed by a low tone, (3b). This is a case of register spread independent of contour.

The structure in (1c) allows a simple characterization of assimilation. In addition to the contour and register spread we have just seen, assimilation also involves the whole tone and the terminal node of tone features. Dissimilation is not as active as assimilation. It typically targets contour, as shown in the two disyllabic tone melodies in Pingyao, a Jin dialect (80).

(4) (a) 35-35→53-35
    (b) 53-53→35-53

Contour dissimilation is formally expressed as metathesis of the terminal nodes of (1c). Across Chinese dialects contour dissimilation is common. Register dissimilation, by contrast, is rare. The assimilatory and dissimilatory tendencies are summarized below.

(5)

	contour	register
assimilation	less common	more common
dissimilation	more common	less common

[3] In addition to L, M and H, Chen uses numbers to transcribe tone, with 1 representing low pitch, and 5 high pitch. I follow Chen's notation. For the sake of perspicuity, abbreviated names of constraints are spelled out.

Chen attributes this state of affairs to functional motivation: contour dissimilation reduces tonal complexity by turning, for example, rise-rise to fall-rise (a concave contour) or fall-fall to rise-fall (a convex contour). Register dissimilation and contour assimilation perform no such function.

The empirical issue of tonal contour is complicated by the tonological diversity among Chinese dialects. The tonological tendencies summarized in (5) are true of Mandarin and Min dialects. Many Wu dialects, spoken in a region around Shanghai, do not fit in. The tonological behavior these dialects exhibit is consistent with the Africanist tonology, where contour tones are best treated as concatenations of level tones (cf. (1a)). The Pike dichotomy thus transcends geographical boundary.

2. Tone sandhi and Optimality Theory

Chapters 3 and 4 discuss directionality of sandhi rule application in domains longer than two syllables, with data from Tianjin and Changting, respectively. Chapter 5 discusses the mapping between citation and sandhi tones. The data are analyzed in derivational theory and in Optimality Theory (OT; Prince & Smolensky 1993). As Chen shows in these chapters, the OT analyses of the Tianjin and New Chongming data succeed only by subverting the fundamental tenets of the theory. In other words, tone sandhi in Chinese presents an almost insurmountable challenge to OT.

Descriptively, the core of the Tianjin tone sandhi is unremarkable. The dialect has four citation tones, L, H, F and R. Except for H, the initial tone undergoes sandhi if it is followed by an identical tone at some tier of representation. The rules are shown in (6).

(6) (a) LL→RL
    (b) RR→HR
    (c) FF→LF
    (d) FL→HL

These are classic examples of phonological alternation motivated by the Obligatory Contour Principle (OCP). The directionality dilemma emerges in trisyllabic phrases. Of the sixty-four trisyllabic tonal combinations, only seven offer the relevant environment with which to test the interaction of the four disyllabic rules, and to reveal the directionality of their application. Of these, the following two are crucial ((108); * indicates wrong result, double-arrow indicates Backtracking derivation):

(7) (a) (i) Right-to-left path: $\mathrm{R\underline{RR}} \rightarrow {}^{*}\mathrm{RHR}$
        (ii) Left-to-right path: $\mathrm{\underline{RR}R} \rightarrow \mathrm{H\underline{RR}} \rightarrow \mathrm{HHR}$
    (b) (i) Right-to-left path: $\mathrm{F\underline{FF}} \rightarrow \mathrm{\underline{FL}F} \rightarrow \mathrm{HLF}$
        (ii) Left-to-right path: $\mathrm{\underline{FF}F} \rightarrow \mathrm{L\underline{FF}} \rightarrow {}^{*}\mathrm{LLF} \Rightarrow \mathrm{RLF}$

Morphosyntactic constituency plays no role in guiding rule traffic. The analytical quandary here is that the input string RRR requires left-to-right application (7a-ii), whereas FFF requires right-to-left application (7b-i).

Given the rules in (6), both disyllabic and trisyllabic tonal melodies are OCP-compliant.[4] This is crucial for Chen's derivational and OT analyses. The derivational analysis comprises the four rules in (6) and constraints on rule application and output representation. The rules are free to apply left-to-right or right-to-left within a given tone sandhi domain. So in principle, each trisyllabic input may yield two derivational paths (cf. (7)). There are four constraints: Well-formedness conditions (WFC), Temporal Sequence, Preemptive and No-backtracking. WFC comprises two subclauses: OCP, which bars sequences of LL, RR and FF, and OCP′, which bars FL. In other words, WFC regulates the combinations that motivate rules (6). Temporal Sequence favors left-to-right direction in rule application. Preemptive requires that LL, RR and FF be resolved ahead of FL (FFL→LFL→LHL; FLL→FRL). Finally, No-backtracking effectively bars rules from applying in totally derived environments – (6a), for example, cannot apply to LLF to yield RLF, the step marked by ⇒ in (7b-ii). Like constraints in OT, these are violable and ranked. In Tianjin, WFC, Preemptive and No-backtracking are unordered, and all three rank above Temporal Sequence. We have:

(8) {WFC, Preemptive, No-backtracking} $\gg$ Temporal Sequence

What this ranking means is that when the left-to-right derivational path violates WFC, Preemptive or No-backtracking, its right-to-left counterpart surfaces at the expense of Temporal Sequence. Although this analysis avoids overtly stipulating directionality as a condition on rule application, it does so at a cost: there is significant duplication in the empirical motivation of both the rules and the constraints.

Duplication of this type is one of the primary motivations for OT (Prince & Smolensky 1993). Since it makes use of OT-like constraints, the derivational analysis converts easily to a pure OT analysis, by letting GEN(erator) assume the role of (6) and dropping or reformulating derivation-related constraints. Chen attempts two OT analyses, with parallel and serial constraint evaluation. In the parallel analysis, EVAL(uator) is composed of WFC (which is undominated), Faithfulness constraints, Markedness constraints,[5] and *Complex (which penalizes falling and rising tones). For example, HHR (7a-ii) is

[4] For Chen, H, L, F and R are unitary tones at the root level (cf. (1c)), and there is a strict one-to-one mapping between tone and syllable (the tone-bearing unit). Consequently, the trisyllabic HLF in (7b-i) is not equivalent to the disyllabic FF or quadrisyllabic HLHL, and does not meet the structural condition of (6c). I thank one reviewer for comments that led to this clarification.

[5] The Faithfulness constraints are expressed within the correspondence theory of McCarthy & Prince (1995); these are Maximality, Dependence, Identity and Linearity. The Markedness constraints *R (no rising tone), *F (no falling tone), *H (no high tone) and *L (no low tone)

deemed more harmonious than RHR (7a-i) because the former violates the Markedness constraint *R once, whereas the latter commits the same offence twice. (*Complex also favors HHR over RHR.) Between (7b-i) and (7b-ii), it is WFC that ranks HLF above LLF.

The serial OT analysis follows the derivational analysis closely. Following Prince & Smolensky (1993), Chen schematizes harmonic serialism as follows (142):

(9) Input
↓
{a, b, c...} Output$_1$; c = winner
↓
{e, f, g...} Output$_2$; g = winner
↓
etc.

GEN applies to an input to produce an output set whose members differ from the input by one modification. From the output set EVAL picks out a winner, which, in turn, feeds into GEN. This mode of serial evaluation encounters serious difficulty in Tianjin. To illustrate, we recast the derivational paths in (7) in the format of (9), as follows:

(10) (a) FFF
↓
{*FLF, *LFF}
↓ ↓
{!HLF} {*LLF}
↓
{RLF}
(i) (ii)

(b) RRR
↓
{RHR, *HRR}
↓
{!HHR}
(i) (ii)

Forms which violate OCP (*FF, *RR, *LL) and OCP′ (*FL) are marked with an *, and the attested surface forms are marked with an !. In displays (10), *LFF and *HRR violate OCP, and *FLF violates OCP′. Since OCP ranks above OCP′, the path (10a-ii) dies, and GEN applies to *FLF to yield the correct surface form HLF (10a-i). (10b), however, demands the opposite explanation: (10b-i), which violates neither OCP nor OCP′, is not deemed

are ranked $*R \gg *H \gg *F \gg *L$, in accordance with the markedness hierarchy, namely, R is the most marked, and L the least marked.

harmonic; instead, GEN modifies the less harmonic *HRR to yield the desired outcome (10b-ii). The difficulty is due in part to the formal nature of constraints in OT. The surface-true constraints such as OCP and OCP′ are incapable of mimicking the explanatory efficacy of derivational constraints such as No-backtracking and Temporal Sequence. Chen argues that the directionality effect of Tianjin tone sandhi can be accounted for only in an OT theory which allows EVAL to evaluate representations modified by GEN (local) as well as directional paths created by the serial application of GEN (global). In other words, OT constraints cannot be restricted to output representation only, and EVAL needs to include constraints which deal with derivational complexity. This conception of GEN and EVAL renders the serial OT analysis similar in spirit to Chen's derivational analysis (see also Chen 1998).

In chapter 5, Chen turns his attention to the mapping between citation tone and sandhi tone in disyllabic phrases. The two-level relationship lends itself to an OT analysis with parallel harmonic evaluation. New Chongming has eight citation tones: 2 evens (*ping*), 2 falls (*shang*), 2 rises (*qu*) and 2 'checked' tones (*ru*), which are divided into the high (*yin*) and low (*yang*) registers. Interestingly, its disyllabic compounds exhibit only nine tonal melodies, out of a total of sixty-four input sequences. The constraints that constitute EVAL are defined on the basis of the observable properties of these nine melodies. The constraint *E/O is based on the observation that none of the melodies is made up of an even tone (E) and an oblique tone (O, either fall or rise), and the constraint E$\neq$O on the observation that the contouredness of the input is preserved in tone sandhi – a rise may become a fall, and vice versa, but not an even, and an even remains unchanged. Altogether, seven constraints are defined in this manner. These constraints are undominated as a matter of definition. Other constraints are ranked. To see how they rank, consider (11) (q = checked syllable, o = de-toned syllable; adapted from table 5.1).

(11) (a) (i) Eq-E → o-E
(ii) Eq-O → o-O

(b) (i) O-E → o-E
(ii) E-O → E-o

Note that the input in (11a-ii, b) violates the undominated constraint *E/O. The resolution of this violation requires three constraints *Tq ('A checked syllable in initial position may not carry tone'), Parse-E ('Parse even tone') and Parse-T ('Parse any tone'). They must be ranked *Tq $\gg$ Parse-E $\gg$ Parse-T. In 11(a), the initial E is deleted due to *Tq, and in (11b), E is parsed over O, due to the higher-ranked Parse-E. Consideration of the other sandhi facts in the dialect motivates two more Parse constraints: Parse-T↑ ('Parse high register tones') and Parse-Tp ('Parse tones in a prominent position'). The four tone-related constraints are ranked as in (12a), which reflects the scale of tonal saliency stated in (12b) (193).

(12) (a) Parse-E $\gg$ Parse-T$\uparrow$ $\gg$ Parse-Tp $\gg$ Parse-T
(b) E $>$ T$\uparrow$ $>$ Tp $>$ T

The scale in (12b) is a composite of contour (E $>$ O), register (H $>$ L), and position (Prominent $>$ Weak).

There are both technical and conceptual problems with the OT analyses presented in chapters 3–5 and summarized above. Here I will focus on problems of a more general nature. There is an implicit assumption that the input (citation) and output (sandhi) tonal sequences are drawn from a uniform inventory of (citation) tones.[6] This is indeed the case for Tianjin, where sandhi tones also occur as citation tones (cf. (6) above). The assumption, however, cannot be taken for granted. There are dialects where a given tone occurs only in sandhi environment. The raised high level and rising tones in Cantonese are such sandhi-only tones (cf. Kao 1971; Yip 1980). In derivational theory, this is a non-issue. Sandhi rules may yield tones which are not used in citation. In OT since GEN is free to generate sequences composed of tones permissible by a general theory of tone (cf. (1) above), the tonal inventory needs to be circumscribed by a constraint to prevent excessive output. Without such a constraint, the input /FFF/ may give rise to output forms such as RMR, MMR, and so on. These illicit output forms necessitate the postulation of *M, in addition to the Markedness constraints already proposed (cf. fn. 5 above), which leads to an improbable markedness ranking: non-occurring tones are necessarily the most marked and undominated. I return to the markedness issue shortly.

More seriously, the OT analyses, complex though they are, fail to provide a complete account of the sandhi phenomena. In the Tianjin analysis, Chen's concern is to demonstrate how OT constraints interact to predict the directionality effect. The candidates to be evaluated are precisely those that would be produced by the rules in (6) in different derivational paths, such as the four in (7). Since GEN is not so restricted, the candidate pool is much larger. Take (7a), for example. Given the input /RRR/, the output candidate pool would include not only RHR and HHR, which are derivable by (6), but also LHR, and indeed all other three-way permutations of R, H, F and L. Other things being equal, the ranking *R $\gg$ *H $\gg$ *F $\gg$ *L would deem LHR more harmonious than either RHR or the observed HHR. The problem persists in both the parallel and the serial analyses. It is not clear to me how the analyses can be made to work without serious curtailment of the output pool

[6] By definition, citation tones are lexical tones read in isolation. In Chinese linguistic literature, it is customary to treat citation tones as underlying, and sandhi tones as surface. There is, however, no a priori reason why this must be the case. It is theoretically possible that both citation and sandhi tones are surface tones derived from common, albeit abstract, underlying tones. For the sake of argument, we follow Chen by equating citation tones with input (underlying) tones, and sandhi tones with output (surface) tones.

or the power of GEN. In Chen's serial analysis, GEN is constrained to 'effect a single modification at a time' (146), in accordance with (6). This move contravenes one of the fundamental tenets of OT: that GEN enjoys unconstrained freedom of analysis (cf. Prince & Smolensky 1993). An unrestricted output pool may overwhelm any reasonably complex EVAL, as we have just demonstrated.

The Markedness constraints (*R, *F, *H and *L) that form part of EVAL in Tianjin prove to be problematic as well. Not only do they not generalize to other dialects, as Chen acknowledges (134), but their ad hoc markedness status and arbitrary ranking are subject to question. Tones are phonemic in tone languages. In Chen's analysis of Tianjin, all four tones are marked, which is equivalent to saying that all phonemes of a language are marked. This absolute sense of markedness differs from the relative sense of markedness embodied in such Markedness constraints as *Complex, a cover constraint which prefers simple to complex constituency. Furthermore, the markedness ranking $R > H > F > L$ (cf. fn. 5) and the saliency ranking $E > T\uparrow > Tp > T$ (cf. (12b)) lack independent motivation, whether in articulation, in perception or in cross-linguistic distribution.[7] One would expect, for example, that a tone in a prominent position (Tp) should be more salient than a tone in a weak position, regardless of contour.

Derivation-related phenomena, especially opacity, prove to be intractable within the input-output representational architecture of OT (cf. Bromberger & Halle 1989), and various proposals have been put forth in the recent OT literature to accommodate them (cf. Kirchner 1996; Ito & Mester 1999; Kager 1999; McCarthy 1999; Dinnsen et al. 2001 and Kiparsky 2001, among others). The step marked by ⇒ in (7b-ii), which is barred by No-backtracking, can be seen as an example of opacity caused by underapplication – rule (6a) is prevented from applying to the derived LL sequence. This state of affairs is not uncommon in Chinese tonology. In fact, the kind of opacity one often encounters in tone sandhi is derivationally shallow, involving only the underlying (input) and surface (output) representations. In OT terms, a form as input may run afoul of a constraint but the same form as output is fine. New Chongming offers a clear case of shallow opacity. The underlying H-HM surfaces as H-o (cf. (11b-ii) above), enforced by *E/O.

[7] Cheng (1973) studies the properties of 3433 tones gathered from 737 dialects. In terms of contour, the tones are distributed as follows:

Fall:	1125
Level:	1086
Rise:	790
Fall-rise:	352
Rise-fall:	80

The top five most frequently used tones are 55, 31, 53, 44 and 35. The statistical profile of the tones does not support the markedness ranking.

By contrast, underlying H-H surfaces as H-HM, in apparent violation of *E/O:

(13) Input: H-HM H-H
↕ ↕
Output: H-o H-HM

Chen's solution crucially depends on representation: the derived HM is not a true contour tone, hence H-HM (<H-H) does not violate *E/O.

A severe case of shallow opacity is the so-called Min Circle, shown below ((82) and chapter 10).

(14) {44, 24}→22→21→53→44

The sandhi patterns are displayed as follows:

(15)	Input:	24	44	22	21	53
		↕	↕	↕	↕	↕
	Output:	22	22	21	53	44

The input tones change into their output counterparts in sandhi environment, regardless of tonal context. Chen calls this paradigmatic substitution. Clearly, this type of opacity cannot be handled by theoretical devices designed to account for derivation-related opacity effects, such as sympathy (cf. McCarthy 1999) and OT strata (cf. Kiparsky 2001). The patterns resemble synchronic chain shifts, discussed in the OT literature in Kirchner (1996) and more recently in Dinnsen et al. (2001). The latter work accounts for the *puzzle-puddle-pickle* problem[8] in child language acquisition in terms of local conjunction: two lower-ranked Faithfulness constraints team up to override the effect of the higher-ranked Markedness constraints. What is crucial in these chain shifts is that the word *pickle* is realized as *pickle*. The local conjunction analysis collapses if they form a circle, i.e. *puzzle-puddle-pickle-puzzle* (see tableau 9 in Dinnsen et al. 2001: 513). The Min Circle is such a circle of chain shifts and resists analysis by local conjunction.

Whatever the analysis, it is clear that the Min Circle is not driven by surface markedness considerations. A complicated array of correspondence constraints is needed to account for the Min Circle, and indeed for other cases of shallow opacity.

3. Tone, accent and stress

From OT analyses of tone sandhi, Chen turns his attention to the interaction of tone and accent in chapter 6 and to tone sandhi domains: the metrical foot

[8] Simply put, the *puzzle-puddle-pickle* problem is a chain shift in which the word *puzzle* is realized as *puddle*, the word *puddle* as *pickle*, and the word *pickle* as *pickle*.

in chapters 7 and 8, the Minimal Rhythmic Unit in chapter 9, and the phonological phrase in chapter 10. Chapter 11 discusses intonation.

For Chen, accent is a marker of prominence, which is manifested differently across Chinese dialects. There are two theoretical questions that need to be addressed. First, since tones must be lexically specified, is it necessary to postulate the additional tier of accent? Second, if indeed an accentual tier is motivated on empirical grounds, can it be derived in metrical terms? In the broader literature on tone, the answer to these questions has been varied.[9] In this section, I examine Chen's arguments for accentual and metrical structure, and show that, while some tonal systems are indeed accentual, there is no compelling empirical evidence for metrical structure.

Not all modern Chinese dialects are strictly tonal, which is the central theme of chapter 6. In New Chongming, a polysyllabic phrase contains one tonic syllable, and the rest of the syllables are atonic. The tone on the tonic syllable is invariably H. Trisyllabic compounds exhibit only three melodies: [H o o], [o H o] and [o o H]. This is a case of severe neutralization – the 512 trisyllabic permutations of eight citation tones are reduced to just three surface melodies. The accent is determined on the basis of the initial and final tones, as follows ((235); H = high tone, T = any tone, E = even tone, dot = syllable boundary):

(16) *The Accent rule*

(a) H.T.T → H.o.o
(b) T.T.E → o.o.H
(c) T.T.T → o.H.o

The Accent rule applies in the order given: the medial syllable is tonic unless the initial syllable is H, or the final tone is E (even-contoured). In OT terms, the facts in (16) are subject to alignment constraints: AlignL deals with (16a) and AlignR with (16b). (16c) surfaces when both AlignL and AlignR fail, and Culminativity enforces tonicity on the medial syllable.[10] The accentual pattern

[9] An accentual analysis marks a syllable with an asterisk at the underlying representation; the asterisked syllable in turn attracts a tone, typically H (cf. McCawley 1968, 1970; Goldsmith 1984). A tonal analysis removes the diacritic from the underlying representation and associates the tone directly with the syllable (cf. Pulleyblank 1986; Blevins 1993). Attempts have been made to provide a metrical interpretation of tonal or accentual phenomena (cf. Hyman & Katamba 1993; Bickmore 1995); see Odden (1995) for a summary of various attempts at metrical reduction of tonal or accentual systems of African languages. I thank one anonymous reviewer whose comments led to this clarification.

[10] Technically the constraints AlignL ('align accent with the leftmost H') and AlignR ('align accent with the rightmost H') are opaque, for three reasons. First, it is not clear whether H is part of the input string, or the phonetic manifestation of the tonic syllable. Second, AlignR needs to enforce E on the right edge (cf. (16b)), but its formulation does not mention E. Third, in some sense, the H in L.H.L is both the leftmost and the rightmost H. If we assume that H is not part of the input string and AlignL and AlignR refer to the first and last H, respectively, the two constraints make wrong predictions. Chen's tableau on page 246 shows that Hq.H.L surfaces as [o.o.H] [Hq.o.o] being in violation of

of trisyllabic compounds is not sensitive to morphosyntactic structure. The compounds [[MH.MH].LM] and [ML.[L.MH]] both surface as [o.H.o], as predicted by the Accent rule.

In some ways, the New Chongming trisyllabic melody is not a typical accentual system. In the more familiar accentual systems, tonal patterns are derived from the more basic accentual patterns, where accent is determined lexically, as in Japanese (cf. McCawley 1970; Pierrehumbert & Beckman 1988), metrically, as in Kintandu (cf. Goldsmith 1987) and Luganda (cf. Hyman & Katamba 1993), or positionally, as in Tangxi (cf. Kennedy 1953 and below). In New Chongming, accent is derivative. The trisyllabic melodies can be accounted for in terms of the component lexical tones.

If New Chongming has peculiar accentualism, other Wu dialects, among them Tangxi and Shanghai, are undeniably accentual. In these dialects, accent falls on the initial syllable of polysyllabic forms, which retains its lexical tone. Chen tries to reduce accentual structure to metrical structure. Unfortunately, the dialects in question do not offer compelling evidence for a metrical analysis. We consider Tangxi first.

Tangxi has two disyllabic tone sandhi patterns, as exemplified in (17) (→ indicates tone deletion, ⇒ indicates tone spread).

(17)	(a)	As compound:	LH.LH→LH.o⇒L.H
			HL.LH→HL.o⇒H.L
	(b)	As phrase:	LH.LH→o.LH
			HL.LH→o.LH

As can be seen, the initial tone of a compound is retained and spreads rightward. By contrast, the final tone of a phrase is retained, but does not spread, and the atonic syllable surfaces with a default pitch. Since only prominent syllables retain their lexical tones, what is clear from the data is that Tangxi compounds are left-prominent, and phrases are right-prominent. Chen provides a metrical interpretation of syllable prominence: compounds are trochaic, and phrases iambic:

(18) (a) Compound

```
 x
(x .)
```

(b) Phrase

```
   x
(. x)
```

the undominated *Tq. Consider the input string L.H.L, which surfaces as [o.o.H] by (16b). Since AlignL ranks above AlignR, it should surface as [H.o.o]. Both possibilities meet higher-ranked constraints such as *Tq, *E↓ ('No low-register even tone except in initial position') and Culminativity.

The domain of tone sandhi is now the metrical foot, and the tone in a metrically strong position spreads over the entire foot. The foot, however, is not disyllabic. In the data below, it is composed of three or four syllables ((298); cf. Kennedy 1953):

(19) (a) LH.M.LM→LH.o.o⇒L.o.H
(a′) (LH.M)(LM)→(LH.o)(LM)⇒*(L.H)(LM)
(b) HL.HL.HL.HL→HL.o.o.o⇒H.o.o.L
(b′) HL.HL.HL.HL→(HL.HL)(HL.HL)→(HL.o)(HL.o)
⇒*(H.L)(H.L)

The polysyllabic forms do not exhibit the rhythmic effect typical of metrical systems (cf. (19a′, b′)). The data, in fact, can be given a straightforward accentual interpretation. The first syllable of a compound is accented by rule, and the rest are not. The unaccented lexical tones delete and the accented tone spreads over the entire compound. Unlike the case in New Chongming, Tangxi's accent is independent of tone. It is placed positionally.

Similar data are cited from Shanghai. Perhaps the strongest piece of Shanghai evidence comes from tonological behavior that resembles stress clash, as exhibited in the tonal patterns of the two compounds in (20) (309).

(20) (a) (HL.o)[(MH.o)]→(H.L)(M.H)
(b) (LH)[(MH.o)]→(LH.o.o)→(L.H.L)

The parentheses mark metrical feet, and square brackets morphosyntactic structure. (20a) is unremarkable. (20b) is an instance of stress clash, with two abutting tonic syllables. Since compounds are left-prominent, MH is destressed, causing the two feet to merge into a single ternary foot with the surface melody L.H.L.

Stress clash configuration also arises in Chen's analysis of Danyang word melodies presented in chapter 8. De-footing is obligatory in phrases which exhibit stress clash, but optional in phrases with no stress clash, as the following metrical structures show (adapted from (18) in chapter 8 (329)):

(21) (a) x
(x)(x .)→(x . .)
(b) x
(x .)(x)⇒(x . .)
(c) x
(x .)(x .)⇒(x . . .)
(d) x
(x)(x .)(x)→(x . .)(x)⇒(x . . .)

In (21a, d) the first two feet constitute a stress clash, which triggers de-footing by the obligatory Clash Resolution (→). In (21b, c) and (21d), where there is no stress clash, de-footing is effected by the optional Stress Reduction (⇒).

Since a foot constitutes a tone sandhi domain, the forms (21b–d) each have two alternative tonal readings.

While the metrical analysis of Danyang and other Wu dialects has advantages over an end-based account, it has its share of problems. I shall highlight four here. First, the distinction between accentual and metrical structure is not clearly maintained. The same range of Shanghai data is analyzed as accentual in chapter 6, where accent is assigned by rule to the initial syllable of a tone sandhi domain, which is determined independently of accentuation. The Shanghai-style accentualism is also attested in the Southern Min dialect of Xiamen, where accent is assigned to the last syllable of the tone sandhi domain. In chapter 10, Chen presents an end-based account of the Xiamen data based on Chen (1987) and argues against the metrical analysis proposed in Duanmu (1995). The metrical account succeeds no better in Shanghai and other Wu dialects than it does in Xiamen.

Second, the foot in Chinese is not as 'neat' as its counterpart in truly prosodic systems – it may contain any number of syllables, from monosyllabic toned morphemes to polysyllabic phrases (cf. Ao 1993, Yip 1995, 1999). The two types of foot are found in VPs with the structure schematized in (22a); the Shanghai example (22b) is adapted from (49) in chapter 7 (329) (CL = classifier).

(22) (a) $\sigma_1\ [\sigma_2]\ [\sigma_3\ \sigma_4\ [\sigma_5]_{NP}]_{NP} \rightarrow (\sigma_1.o.o.o)\ (\sigma_5)$
(b) paq [ngo] [yiq pəng [sï]]
give me one CL book
'Give me a book.'

In an end-based analysis, the two tone sandhi domains of (22) are demarcated by the parameter {Left, Lex^{max}} ((444); cf. Selkirk & Shen 1990). In the metrical analysis, the first four syllables form one single left-headed foot, merged through de-stressing. The unbounded foot is formally indistinguishable from the accent phrase discussed in chapter 6, and from the p-phrase discussed in chapter 10.

Worse still, a close look at (22a) reveals the technical inadequacy of the metrical account. The string (22a) may be assigned the metrical structure displayed in (23a).

(23) (a)

	x	phrasal stress (VP)
	(. x)	phrasal stress (NP, [σ_3, σ_4, σ_5])
	(x) (x) (x .) (x)	word stress
	$\sigma_1\ [\sigma_2]\ [\sigma_3\ \sigma_4\ [\sigma_5]]$	$\rightarrow (\sigma_1.o.o.o)\ (\sigma_5)$
(b)	paq [NGO] [yiq pəng [sï]]	$\rightarrow (\sigma_1)(\sigma_2)(\sigma_3.o)(\sigma_5)$
	give me one CL book	
	'Give ME three books.'	

The structure in (23a) is produced cyclically in accordance with the metrical rules given on page 307. In (22b), the words occupying the σ_2, σ_3 and σ_4

positions, pronoun, numeral and classifier, are function words, assumed to be unstressed. There is no stress clash in (22b), and ad hoc de-footing must somehow take place to merge the first three word-level feet into a single foot. In Chen's account, the stressless words cliticize to the foot headed by σ_1. But the cliticization account fails in (23b), where *ngo* 'I' heads its own foot due to contrastive stress. The resultant foot structure encodes a double stress clash: σ_2 clashes with both σ_1 and σ_3. This structure is not predicted by the metrical account; see below and fn. 11.

Third, stress clash resolution as shown in the Danyang data (21a, d) does not extend to right-branching compounds of the form [[[(x .)](x)](x)], which surfaces with three tone sandhi domains, despite the fact that the last two unary feet constitute a stress clash. Clash Resolution must be barred from applying in such compounds. This stipulation, as Chen acknowledges, is ad hoc.

Fourth, stress clash is not responsible for the formation of tone sandhi domains in Shanghai, where polysyllabic compounds exhibit the same surface melodies regardless of internal morphosyntactic structure (cf. Zee & Maddieson 1979; Xu et al. 1981–1983):

(24) (a) $(\sigma_1)[(\sigma_2\ \sigma_3)] \rightarrow (\sigma_1.o.o)$
(b) $[(\sigma_1\ \sigma_2)]\ (\sigma_3) \rightarrow (\sigma_1.o.o)$

In a metrical account, (24a) constitutes a stress clash between σ_1 and σ_2,[11] while (24b) is metrically perfect. Duanmu (1997: 472) says that (24b) has two metrical domains $(\sigma_1\ \sigma_2)\ (\sigma_3)$, since it lacks stress clash. This is not true. Zee & Maddieson (1979) and Xu et al. (1981–1983) are full of examples of the form (24b) with a single tone sandhi domain. The two compounds in (25) are cited from Xu et al.'s work.

(25) (a) [le du] zong $\rightarrow (\sigma_1.o.o)$
lazy inert insect
'lazy bones'
(b) [ni jiu] sang $\rightarrow (\sigma_1.o.o)$
research student
'graduate student'

[11] Contrastive stress on $[\sigma_2\ \sigma_3]$ will turn it into a left-headed foot, resulting in stress clash:

(i) $(\sigma_1)(\sigma_2\ o)$
(cf. $(\sigma_1\ o\ o)$)

Duanmu (1995: 233) remarks that, because of the resultant stress clash, it is not possible to place contrastive stress on $[\sigma_2\ \sigma_3]$. This assertion is questionable. In my own speech, and in the speech of a few fellow native speakers I consulted, the following utterance is perfectly acceptable:

(ii) ngo yao [(hõ) [(moq zã)]], vəq yao [(hõ) [(t'iq zã)]]
I want red wood bed not want red iron bed
'I want a red WOODEN BED, not a red IRON BED.'

The initial tone in each case is LH. Hence, the two compounds have the tone pattern L.H.L. (cf. (20b) above).

The metrical structure in (24), represented by the parentheses, is assigned cyclically in accordance with the analysis developed in Duanmu (1995, 1997), which is adopted in Chen's work and in Kenstowicz (1995). There are two crucial components to Duanmu's analysis: cyclic assignment of left-headed feet and merger of feet due to stress clash. The analysis predicts that compounds with different morphosyntactic constituency exhibit different tone patterns. For example, exclusively right-branching and exclusively left-branching quadrisyllabic compounds are expected to exhibit the patterns shown in (26).

(26) (a) $[(\sigma_1)[(\sigma_2)[(\sigma_3)(\sigma_4)]]] \rightarrow (\sigma_1\ \sigma_2\ \sigma_3\ \sigma_4)$
(b) $[[[(\sigma_1)(\sigma_2)](\sigma_3)](\sigma_4)] \rightarrow (\sigma_1\ \sigma_2)\ (\sigma_3\ \sigma_4)$
(b′) $[[[(\sigma_1)(\sigma_2)](\sigma_3)](\sigma_4)] \rightarrow (\sigma_1\ \sigma_2)\ (\sigma_3)\ (\sigma_4)$

(26a) is cited from Duanmu (1997: 482), and (26b, b′) are consistent with the cyclic analysis: (26b) if (σ_3) and (σ_4) are interpreted as clashing, (26b′) if they are not. Again, the data, which are readily available in Xu et al. (1983), do not support (26):

(27) (a) [ue [tsu [nin ka]]] → $(\sigma_1.\text{o.o.o})$
can do person home
'thrifty'
(b) [[[yu-uã) ju] jiao] → $(\sigma_1.\text{o.o.o})$
wronged ghost cry
'cry of a wronged ghost'

In Xu et al. (1981–1983), (27a, b) are examples of the so-called 'broad' sandhi type,[12] which is the most common type of tone sandhi in Shanghai compounds. Regardless of the internal morphosyntactic structure, the compounds exhibit the same tone pattern, controlled by the initial tone. If metrical structure underpins Shanghai tonology, one would expect compounds of the form $[[\sigma_1\ \sigma_2][\sigma_3\ \sigma_4]]$ to surface as $[[(\sigma_1\ \sigma_2)][(\sigma_3\ \sigma_4)]]$ (cf. (20a)), with two optimal binary feet that align perfectly with the morphosyntactic boundary. In fact, many such compounds, especially the 'structurally tight' ones, belong to the broad

[12] Xu et al. (1981) define the distinction between the broad and narrow types morphosyntactically. The narrow type applies to compounds of a few grammatical constructions, such as verb-object and subject-verb, and to compounds which are not words. The broad type is the default type, especially for compounds which are clearly words. Generally speaking, narrow-type compounds exhibit alternative broad-type sandhi, but not vice versa. Phrases generally follow narrow-type patterns.

type, which allows a single tone sandhi domain, like those in (28) (Xu et al. 1983: 197):

(28) [[kõ ɕin] [t'ã tø]] → (σ_1.o.o.o)
empty heart soup dumpling
'dumplings without fillings, i.e. things of no substance'

It is worth noting that metrical rhythm, as represented by binary feet, is more commonly found in transliterations such as (*au.ta*)(*li.ya*) 'Australia' than in quadrisyllabic native compounds. Some compounds – the 'narrow' types in Xu et al. (1981–1983) – sport two domains, but these are not metrical feet. The four narrow types are as follows (Xu et al. 1983: 197–198):[13]

(29) (a) [qo-yã] [tɕo-zɤ] → (σ_1.o)(σ_3.o) (cf. (20a))
Ou-Yang professor
'Professor Ou-Yang'
(b) [sɿ̈ ti] [vəq] [dʑin] → ($\sigma_1\sigma_2\sigma_3$)(σ_4)
four limb not diligent
'lazy'
(c) [fong] [ho] [ɕiq] [ɦiq] → (i) ($\sigma_1\sigma_2\sigma_3$)(σ_4) (ii) (σ_1)(σ_2)(σ_3)(σ_4)
wind flower snow moon
'wind, flower, snow, moon'
(d) niq [[du do] huen] → (σ_1)(σ_2.o.o)
hot pig head faint
'hot-headed, unrealistic'

Not all domains in these compounds can be derived cyclically and merged under pressure from stress clash. Indeed, (29c-ii) and (29d) are precisely the stress clash structures prohibited by the metrical analysis.

Facts like these cast serious doubt on the ontological necessity of metrical structure in a parsimonious theory of Chinese phonology. The Shanghai and Danyang data can be readily accommodated in an account that makes no reference to metrical notions. In both dialects, the tonal melody of the relevant tone sandhi domain – the compound in Shanghai and Danyang, or the string demarcated by {Left, Lex^{max}} – is largely determined by the tone of the first syllable. The non-initial lexical tones play no role. This motivates an alternative, nonmetrical analysis in which accent is assigned to the first syllable and unaccented tones are subsequently deleted, paving the way for other tonological processes, which ultimately produce the surface tonal melodies in the respective dialects. Some of the putative metrical effects,

[13] The four narrow types differ from the broad type in details of tonal realization, which need not concern us here. In narrow types (29b, c), the first three syllables undergo sandhi, but the last syllable retains its lexical tone. In narrow type (29d), the first tone may but need not undergo sandhi. When it does, which is more common, it is independent of the neighboring sandhi domain, which exhibits the trisyllabic broad-type sandhi (Xu et al. 1983: 197–198).

especially those found in transliterations, can be attributed to the strong disyllabic tendency in Chinese (cf. Lü 1963; Chao 1968; Duanmu 1995, 1997), a tendency which Chen tries to capture with the notion Minimal Rhythmic Unit (chapter 9; cf. Shih 1986). Though optimally disyllabic, this notion is not the same as the metrical foot, and is not part of the familiar prosodic hierarchy.

Typologically, Chinese tone systems oscillate between tone and accent. Some dialects are tonal (Tianjin), others accentual (Danyang, Shanghai) and still others hybrid (Chongming). No system, to paraphrase McCawley (1970), has quite made it to being metrical. Not surprisingly, Chinese accentualism retains tonal characteristics. Tones must still be lexically specified and the tonal melody of a polysyllabic constituent is largely shaped by the lexical tone of the initial syllable – directly in Shanghai and indirectly in Danyang.[14] This contrasts with truly accentual systems, such as Japanese and English (cf. Pierrehumbert & Beckman 1988; Ladd 1996) and Proto-Bantu (cf. Goldsmith 1984), where accent is assigned either lexically or by rule, and anchors the realization of tonal melodies.

4. Conclusion

This voluminous work represents more than a decade of research by Chen and his students on tonological issues in Chinese, much of which is already familiar to students of Chinese phonology. It synthesizes the work of many scholars working in traditional Chinese linguistics and in modern generative phonology. Although details of interpretation and analysis are bound to be controversial, and the OT-theoretic apparatus superseded by the rapid development of the theory, the book clearly reveals the complexity and diversity of tone and tone sandhi among Chinese dialects. It is a valuable addition not only to Chinese linguistics but also to general tonological scholarship.

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[14] Danyang has a total of six word tonal melodies, which must be specified separately from the lexical tones. The assignment of tonal melodies to words depends on the initial syllable; see Lü (1980), Bao (1990, 1999b) and Duanmu (1990), among others.

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