Left-headed Feet and Phrasal Stress in Chinese
(Les Pieds gauche-forts et Accent de Phrase dans le chinois)

San DUANMU
University of Michigan
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Department of Linguistics
University of Michigan
Ann Arbor, MI 48109-1285
USA
E-mail: duanmu@umich.edu
Fax: 734-936-3406

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San DUANMU

Duanmu (2000) proposes that Standard Chinese has left-headed feet. In addition, in compounds and phrases stress is assigned to the syntactic non-head. Dell (2004) raises a number of questions for Duanmu's analysis. I explain how the questions can be addressed. I also offer some new evidence and argue that the analysis with left-headed feet remains the simplest theory.
Key words: Chinese, phonology, foot, phrasal stress

Duanmu (2000) propose que l'accentuation du chinois standard est caractérisée par des pieds accentuels dont la tête est à gauche. De plus, dans les mots composés et dans les syntagmes, le constituant immédiat qui reçoit l'accent principal est celui qui ne joue pas le rôle de tête syntaxique. Dell (2004) soulève divers problèmes touchant l'analyse de Duanmu (2000). Je propose des solutions à ces problèmes. Je présente en outre de nouveaux arguments en faveur d'une analyse qui postule des pieds dont la tête est à gauche, et je montre que cette analyse est la plus simple.
Mots-clé: chinois, phonologie, pied, accent principal de syntagme.

1. INTRODUCTION

Standard metrical theory (such as Halle and Vergnaud 1987, Halle and Idsardi 1995, and Hayes 1995) defines stress as the head of a metrical constituent. On this view, whenever there is a foot, there is a stress, and vice versa. Given the assumption, there are four options in the analysis of stress in Chinese. First, Chinese has no stress or foot structure. Second, Chinese has left-headed feet. Third, Chinese has right-headed feet. Fourth, Chinese has a unique rhythmic unit, which is different from metrical feet. Duanmu (2000) argues that of the four options the second (left-headed feet) is the most plausible. Let me offer a brief review the arguments.

The no-stress view is motivated by the fact that stress is often less obvious in Chinese than in English. For example, English speakers can agree that in *oil lamp* the first syllable has more stress. In contrast, Chinese speakers often cannot tell which syllable in the corresponding expression *you deng* 'oil lamp' has more stress. For this reason, works on Chinese phonology rarely discuss stress, and some linguists (such as Hyman 1977 and Selkirk and Shen 1990) believe that Chinese has no stress. There is, however, some evidence to the contrary. First, there is a clear stress difference between a full syllable and a weak syllable in Standard Chinese (SC).[1] Weak syllables (mostly grammatical words) are short, have a reduced rime, and do not have carry lexical tones

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[1] SC is based on the Beijing dialect, although not all Beijing residents speak SC. Since the difference between the two is not relevant for the present discussion, I use SC through out, instead of Beijing Mandarin, which Dell (2004) uses.

(Lin and Yan 1988). Full syllables (mostly content words) have lexical tones and are long. Second, Chinese does use stress in contrastive expressions, such as (1), transcribed in Pinyin, where words in uppercase have contrastive stress.

(1) wo xing HUANG, bu xing WANG
I name Huang, not name Wang
'I am named HUANG, not named WANG.'

If Chinese uses contrastive stress, it is possible that it uses other stress as well (I return below to why stress in Chinese is not as obvious as in English). Third, some studies, such as Chao (1968) and Hoa (1983), show that, although stress judgment is subtle, certain patterns can still be described. Fourth, a disyllabic unit plays a prosodic role in several ways in Chinese. For example, a minimal expression often must be disyllabic, so that a monosyllabic name must be used with a semantically redundant syllable; thus, *Fa* 'France' is not spoken alone but as *Fa guo* 'France country', and *Wu* 'Wu (name of a mountain)' is not spoken alone but as *Wu shan* 'Wu mountain'. In contrast, disyllabic place names such as *Sudan* 'Sudan' and *Emei* 'Emei (name of a mountain)' can be spoken without *guo* 'country' or *shan* 'mountain'. Similarly, the disyllabic unit plays a role in poetic meter (Chen 1979, Duanmu 2004). There are two possible analyses of the disyllabic unit: it is a foot, or it is a phonological word. It is easy to show that it is not a phonological word. According to Selkirk (1986), Nespor and Vogel (1986), and Hayes (1989), the phonological word is a lexical word plus its inflections (and perhaps any functional words around it). If so, monosyllabic names like *Fa* and *Wu* are already phonological words, and there is no reason for them to need another syllable. The most natural analysis of the disyllabic unit, therefore, is that it is a foot.

Next consider the proposal of right-headed stress. Chao (1968: 38) points out that native judgment is often difficult to obtain on relative stress among full syllables in SC, but he suggests that in a string of full syllables, the final syllable has most stress, the initial syllable has slightly less, and other syllables have still less. Hoa (1983) and Chen (2000) hold a similar view, to which I return later. The proposal is supported by the fact that when an expression is spoken in isolation the final syllable is longer, which has been confirmed by phonetic studies (Yan and Lin 1988). Nevertheless, there are two problems for assuming right-headed feet. First, when an expression is read in a carrier sentence, its final syllable is no longer the longest, but its first syllable often is (Wang and Wang 1993). This means that the longer duration of the utterance final syllable is probably the result of pre-pause lengthening (Klatt 1976), instead of final stress. Second, right-headed feet cannot explain why the initial syllable is the next strongest, unless left-headed feet are also assumed; I will return to this issue below.

Next consider the proposal that Chinese has a special prosodic entity. According to Chen (2000), each full syllable in SC is a moraic foot, which enables the syllable to have stress (as compared with a weak syllable) and retain its lexical tone. As a result, the disyllabic prosodic unit cannot be a foot, because in the theory of prosodic hierarchy there is only one category for the foot. In addition, the disyllabic unit does not fit into any other category in the prosodic hierarchy either. Therefore, Chen concludes that the disyllabic unit is something unique to Chinese, which he calls the Minimal Rhythmic Unit (MRU). This analysis has problems, too. First, in metrical theory, metrical

constituents can be constructed on multiple layers; what are commonly called feet are but metrical constituents at the bottom layer (Halle and Vergnaud 1987, Hayes 1995). For example, according to Hayes (1995), English has moraic feet. However, to distinguish primary stress from secondary stress, (at least) two layers of metrical constituents are needed. An example is shown in (2), where M indicates a mora.

```
(2)      x
        (x     x  )          Syllabic foot
        (MM)(MM)             Moraic foot
        Alpine
```

In *Alpine*, each syllable forms a moraic foot and has stress. To represent primary stress, another layer of metrical constituent is needed. Second, Chen (2000: 301) assumes that a MRU can have two or more syllables each, and it can have different stress patterns, such as (SW) in *ma-ma* 'mom', (WS) in *bo-luo* 'pineapple', (SWS) in *bo-luo kuai* 'pineapple cube', and so on. If so, the MRU cannot be a metrical foot, as Chen points out. Since the MRU is such an unusual theoretical construct, its use should be supported by compelling evidence. I will argue that MRU is unnecessary and left-headed syllabic feet suffice to serve the purpose.

Let us now consider left-headed feet. Duanmu (1999, 2000) proposes that the basic metrical structure in Chinese includes both the moraic trochee (left-headed moraic feet) and the syllabic trochee (left-headed syllabic feet), which can be called the dual-trochee. A minimal dual-trochee is made of either a full syllable and a weak syllable (heavy-light) or two full syllables (heavy-heavy), as shown in (3).

```
(3)                          heavy-light      heavy-heavy
                               x                x
        Syllabic trochee:     (σ    σ)         (σ      σ)
                               /\   |           /\     /\
        Moraic trochee:       (MM) .M          (MM) . (MM)
                               x                x      x
```

The dual-trochee distinguishes three degrees of stress: (a) a heavy syllable that heads a syllabic foot, (b) a heavy syllable that does not head a syllabic foot, and (c) a light syllable. The moraic trochee distinguishes a full syllable (stressed) from a weak syllable (unstressed). The distinction is quite clear phonetically: a full syllable is long and has an unreduced rime and a lexical tone, whereas a weak syllable is short and has a reduced rime and no lexical tone (Lin and Yan 1988). The syllabic trochee represents the disyllabic unit that plays various prosodic roles. However, the phonetic difference between the syllables in a heavy-heavy foot is not very obvious, because both are long, have a lexical tone, and have an unreduced rime. What is the evidence then to consider the syllabic foot to be left-headed, besides subtle phonetic judgment? There are three reasons. First, in Chinese a disyllabic word can be heavy-heavy or heavy-light, but there is no disyllabic word that is light-heavy; this follows from the left-headed analysis. Second, in languages like English, the first syllable of a disyllabic compound (such as *blackboard* and *pancake*) has more stress. Since Chinese has the same word order as

English, the null hypothesis is that the first syllable of a disyllabic Chinese compound also has more stress. Third, in Chinese poetry, disyllabic words generally occupy positions that are SW (strong-weak), in agreement with the left-headed analysis (see section 3).

Having discussed foot structure, let us consider stress assignment. Word stress is less controversial. According to Duanmu (2000), in polysyllabic names and digits, disyllabic trochaic feet are constructed from left to right. Hoa (1983) essentially holds the same view, although she assumes that main stress falls on the final syllable. Shih (1986) and Chen (2000) also assume left to right foot formation.

For compounds and phrases, there is more disagreement. Hoa (1983) suggests that phrasal stress depends on tree structure. At every branching node the right-hand branch is stronger (subject to further modifications, such as stress clash avoidance). Duanmu (2000) proposes that the syntactic non-head should have stress, and because the syntactic nonhead is on the left in compounds and on the right in most phrases, stress is assigned to the left in compounds and assigned to the right in most phrases.[2] Thus, Duanmu and Hoa agree on word and phrasal stress, but differ on compound stress. However, as I will discuss below, if we exclude the effect of final lengthening, and given additional rules that Hoa assumes, such as stress clash avoidance and inversion, the analyses of Hoa and Duanmu often give the same results. Shih (1986) suggests that feet are constructed for disyllabic terminal nodes first and then linearly left to right; finally, a stray syllable is adjoined to its nearest foot. Chen (2000) assumes a similar analysis as Shih for phrases, but follows Hoa for compounds.

Hoa's proposal is primarily based on her native speaker intuitions about relative prominence. The proposals of Shi (1986) and Chen (2000) are primarily based on tone sandhi. Arguments for Duanmu (2000) are drawn from a range of seemingly unrelated problems, both in Chinese in general and in SC in particular. They include the word order and word length problems in Chinese, tone deletion and spreading in Wu dialects, the difference between full and weak syllables, the distribution of weak syllables, and tone sandhi in SC. I will also argue below that Duanmu's proposal is supported by the phonetic judgment of Hoa (1983) and meter in Chinese verse.

Dell (2004) raises a number of problems for Duanmu (2000) and concludes that Duanmu 'fails to present any solid phonological evidence in favor of left-headed stress in Standard Chinese'. Although many of Dell's criticisms are well made, his conclusion seems premature, because he does not discuss whether the problems are solvable in Duanmu's analysis or whether other theories can do better. In section 2 I address the problems raised by Dell and offer some solutions. In section 3 I discuss further evidence for left-headed stress. In section 4 I offer conclusions.

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[2] In this sense, the non-head stress rule achieves similar effects as the Compound Stress Rule and the Nuclear Stress Rule combined (Chomsky and Halle 1968). The reader might be puzzled, therefore, by Dell's (2004) remark that 'the distinction between words and phrases does not play any role in (Duanmu's analysis)'. What Dell means is not that Duanmu assigns stress in the same direction in compounds and phrases, but that (a) Duanmu uses a single stress rule for compounds and phrases and (b) Duanmu assumes that both compound stress and phrasal stress occur before tone sandhi. I discuss the issue (b) in section 2.2.

2. PROBLEMS AND SOLUTIONS

Dell (2004) does not review the entire book of Duanmu (2000) but only focuses on two topics: stress (chapter 6) and tone sandhi (chapter 11). I address each problem he raises in turn.

2.1. Intermediate steps in cyclic stress assignment

The first problem concerns Duanmu's cyclic analysis of compounds, where stress is assigned to the left. Consider the compound in (4), from Dell's (8), based on Duanmu (2000: 138). (For the distinction between compounds and phrases in Chinese, see Dai 1992, Duanmu 2000, and Chen 2000).

```
(4)   (a)                 (b)                 (c)
                            x
        x                   x    x              x
      (x  x  )            (x)  (x  x  )        (x    x  x  )
      [xiao [ ya dan] ]   [xiao [ ya dan] ]    [ xiao [ya dan] ]
      'small duck egg'
```

On the inner cycle, [*ya dan*] 'duck egg' forms a foot, where stress is assigned to *ya* 'duck', shown in (4a). On the outer cycle, *xiao* 'small' gets more stress than [*ya dan*], as in (4b). Since each stress implies a foot, *xiao* is a foot by itself. However, because a foot should be at least disyllabic, *xiao* cannot be a foot all by itself. The solution, according to Duanmu (2000: 133), is for the two feet to merge into one, as in (4c).

Dell argues that there is a conceptual problem in (4): if a monosyllabic foot is not allowed, there simply cannot be the step in (4b), and so Duanmu's analysis is impossible. However, it is worth noting that (4b) is an intermediate step, not the final step. Such intermediate steps are used in other analyses, too, such as Hoa (1983) and Chen (2000), which Dell seems to favor. For example, Hoa (1983: 42-43) proposes that because of stress clash an inversion rule will change [[W S] S] to [[S W] S], illustrated in (5).

```
(5)        x                  x
         x x                x   x
       •  •  •    →       •  •  •
```

Dell might want to raise the same question here: if [[W S] S] is not allowed at surface, how can it be allowed in an intermediate step? Chen (2000: 301) assumes the same analysis of Hoa, but no question was raised by Dell either. Indeed, Dell might raise the question for the derivational approach in general, because any restructuring process must have a way to represent an undesirable form before it is changed to a better one.

There is a way to avoid ill-formed intermediate steps altogether, which is to adopt Optimality Theory (Prince and Smolensky 1993). For example, if we have the constraints in (6), we can get the analysis in (7) (the analysis here is somewhat simplified; for a more detailed analysis of cyclic stress in Optimality Theory, see Duanmu 1997).

(6) Constraints
Binarity: A foot must have at least two beats
Left: A compound must begin with a foot
Parse: Syllables must be parsed into feet
Binarity >> Left, Parse

(7) Analysis of the compound in (4)

	[σ [σ σ]]	Binarity	Left	Parse
√	(σ σ σ)		*	
	(σ)(σ σ)	*		
	σ (σ σ)		*	*

In (7), (σ)(σ σ) violates the top ranked Binarity. (σ σ σ) violates Left for the inner compound. σ(σ σ) violates Left for the outer compound, as well as Parse. So the best pattern is (σ σ σ).

In summary, imperfect intermediate steps are not a specific problem for Duanmu (2000) but part of derivational analyses in general, including Hoa (1983) and Chen (2000), which Dell seems to favor. In addition, such representations are avoidable in Optimality Theory without sacrificing the idea of left-headed feet.

2.2. Cyclicity: compounds vs. phrases

In SC, there is a rule, commonly called Tone 3 Sandhi (T3S), that changes T3 to T2 before another T3, or 3-3 → 2-3 (the hyphen indicates a syllable boundary). Dell (2004) points out that in order for T3S to apply properly in Duanmu (2000), feet much be build before T3S applies. Consider the example in (8), where digits represent tonal categories.

(8)
```
                x            x    x
  3   3  (3  1)  →  (3 3)(3 1) →  (2 3)(3 1)
```
[xiang [mai [hao shu]]]
want buy good book
'(I) want to buy good books'

In (8) the compound [*hao shu*] forms a foot first. Then the first two free syllables form another foot by a separate rule that builds a foot from left to right (the rule is proposed by Shih 1986 and is adopted by Chen 2000 and Duanmu 2000). Finally, T3S obligatorily applies to 3-3 within a foot, but T3S over 3-3 between feet is optional. Thus, 2-3-3-1 is a possible result (among other alternatives).[3] It can be seen that if T3S applies cyclically without foot formation, the default result would be 3-2-3-1, which is incorrect.

However, Dell points out that in compounds T3S must apply cyclically. To do so, syntactic boundaries must be kept after foot formation. Consider the compound in (9).

[3] Some speakers may find it more preferable, or perhaps required, to apply T3S between feet. I follow Shih (1986) and Chen (2000) in assuming that T3S is optional between feet.

(9)
```
 x    x    x            x
 3    3    3 1    →  (3  3  3  1)  →  (3 2 3 1)
[xiao [zhi [lao-ying]]]  [   [   [    ]]]
small paper eagle
'small paper eagle'
```

First, the first three syllables will receive stress via cyclic compound stress assignment. Then, owing to foot binarity (and stress clash), only the first stress is kept, giving one foot for the entire compound. Next T3S applies cyclically, giving 3-2-3-1 as the neutral pattern. Crucially, if the syntactic brackets are not kept after foot formation, there is no way to apply T3S cyclically.

Dell argues that the analysis in (9) is incompatible with the standard theory of cyclicity, according to which syntactic brackets should be erased after each cycle (this has been called 'bracket erasure' in the literature). In other words, after foot formation the internal syntax should all be lost and so there is no way to apply T3S cyclically. A better analysis is for both foot formation and T3S to apply cyclically, as shown in (10). For clarity I have underlined the syntactic nonhead in the input, which gets stress in Duanmu's analysis.

(10)	[3 [3 [3 1]]]	Input/stress	Foot form	T3S
		x		
	Cycle 1	[3 1]	(3 1)	(3 1)
		x		
	Cycle 2	[3 (3 1)]	(3 3 1)	(2 3 1)
		x		
	Cycle 3	[3 (2 3 1)]	(3 2 3 1)	(3 2 3 1)

However, the cyclic analysis cannot apply to (8), where foot formation must apply left to right after a terminal binary foot is built. Dell concludes, therefore, that in Duanmu's analysis T3S must wait till all feet have been built, which then faces the question of bracket erasure.

One will note that there is a structural difference between (8) and (9): the former is a phrase and the latter is a compound. In Chen (2000), which Dell seems to prefer, a stipulation is made so that foot formation and T3S are cyclic for compounds but left to right for phrases (after a terminal binary foot is built, which is another stipulation). It is possible for Duanmu to make the same stipulation, which does not affect the idea that feet are left-headed. If so, the analysis of (8) will be (11).

(11)	[3 [3 [3 1]]]	Input	Foot form	T3S
	Compound	[3 1]	(3 1)	(3 1)
	Phrase (L→R)	[3 [3 (3 1)]]	(3 3)(3 1)	(2 3)(3 1)

The result is correct. The same analysis applies to left-branching compounds, such as (12), analyzed in (13), where an underline indicates the syntactic nonhead.

(12) 3 3 3 3 → 2 2 2 3
[[[zhan-lan] guan] li]
exhibit hall inside
'Inside the exhibition hall'

(13)	[[[3 3] 3] 3]	Input/stress	Foot form	T3S
	Cycle 1	x [3 3]	(3 3)	(2 3)
	Cycle 2	x [(2 3) 3]	(2 3 3)	(2 2 3)
	Cycle 3	x [(2 2 3) 3]	(2 2 3 3)	(2 2 2 3)

On cycle 2 and cycle 3, the final syllable can join the foot to its left, because the resulting foot is still left-headed.[4] Thus, for such compounds there is no left to right foot formation, which clarifies a query in footnote 24 of Dell (2004).

2.3. Unfooted syllables and branching structure

One difference between Chen (2000) and Duanmu (2000) is that for Chen all syllables must be footed, but for Duanmu some syllables can remain outside a syllabic foot. Consider the example in (14).

(14) 3 3 1 → 2 3 1
[mai [hao shu]]
buy good book
'buy good books'

For both Chen and Duanmu, the compound [*hao shu*] forms a foot. For Chen the verb *mai* will join the foot at the phrase level to form a 'super-foot', but for Duanmu *mai* will remain outside the foot, because *hao* has phrasal stress and should remain in foot initial position. The difference derived from different theoretical assumptions. If one believes that it is more important to parse all syllables than for feet to have a consistent head direction, one may adopt Chen's position. In contrast, if one believes that it is less important to parse all syllables than having a uniform foot structure, one may adopt Duanmu's position. A similar difference exists for English expressions such as *to travel* and *Chicago*, where some linguists believe they form one foot each (either a super-foot or a nested foot), while others believe that the first syllable in each case is outside the foot.

[4] The idea that a free syllable can join the foot to its left is discussed in Duanmu (2000: 137-139). However, if a free syllable must undergo T3S when it occurs next to a T3 in a foot, as in '3(3…' and '…3)3' (see section 2.3 below), there is no need to assume that the final syllable on cycle 2 and cycle 3 in (13) must merge into the foot on its left.

Of interest is the fact that the first syllable in (14) must undergo T3S. In Chen's analysis, it is because it is inside a foot, where T3S is obligatory. In Duanmu's analysis, it is because a free (unfooted) syllable must undergo T3S. Thus, while their assumptions differ, both analyses can account for structures like (14).

When a free syllable occurs between two feet, there is the question of whether it should undergo T3S with the preceding or the following syllable. Consider (…3) 3 (2…). If the free syllable is grouped with the following foot, it does not need to change, because 3-2 does not trigger T3S. If the free syllable is grouped with the preceding foot, T3S should apply, because there is a 3-3 sequence. Consider the examples in (15) and (16).

(15) 3 3 3 2 3 → (2 3) 3 (2 3)
[wo [xiang [mai pi-jiu]]]
I want buy beer
'I want to buy good wine.'

(16) 1 3 3 2 3 → (1 2) 3 (2 3)
[[kan-guan hao] pi-jiu]]
Watch well beer
'Watch well over the beer'

In (15) T3S need not apply, which means that the free syllable is grouped with the following foot. In (16) T3S must apply, which means that the free syllable is grouped with the preceding foot. The examples show that a free syllable is grouped according to syntactic bracketing. Chen's analysis of (15) is shown in (17), where the super-foot formation observes syntactic bracketing.

(17)	[3 [3 [3 [2 3]]]	Input	Foot form	T3S
	Compound	[2 3]	(2 3)	(2 3)
	Phrase (L→R)	[3 [3 [3 (2 3)]]]	(3 3) [3 (2 3)]	(2 3) [3 (2 3)]
	Super-foot	(2 3) [3 (2 3)]	(2 3)(3 2 3)	(2 3)(3 2 3)

In (17) the free syllable and the following foot are branching sisters, and so they form a super-foot. Duanmu's analysis is similar, although instead of a super-foot, T3S applies one more time on the free syllable according to the bracketing structure, shown in (18).

(18)	[3 [3 [3 [2 3]]]	Input	Foot form	T3S
	Compound	[2 3]	(2 3)	(2 3)
	Phrase (L→R)	[3 [3 [3 (2 3)]]]	(3 3) [3 (2 3)]	(2 3) [3 (2 3)]
	T3S			(2 3) [3 (2 3)]

Dell (2004, section 3.3) argues that in Duanmu's analysis T3S is sensitive to 'a hybrid' of conditions, both stress feet and morphosyntactic structure. It can be seen that Chen's analysis requires similar complexity, although the burden is shifted to the foot formation process: the foot looks at syntax at the compound level, ignores syntax at the phrase level, and then looks at syntax again at the super-foot level. A hybrid of conditions seems to be what is needed to account for T3S, regardless of the approach.

2.4. Disyllabic unit and Foot Shelter

Chen (2000) assumes that a disyllabic unit always forms a foot, regardless of its syntax. Duanmu (2000: 123) makes a similar assumption, which he calls the Foot Shelter effect: the syntax inside a disyllabic unit can be ignored so that it is treated like a single word or compound. For illustration, consider the compound in (19), from Dell's (21a), where the second syllable must undergo T3S. The analysis is given in (20).

(19) 4 3 3 → 4 2 3
[[zao tong] chang]
make pail factory
'pail-making factory'

(20)	[[4 3] 3]	Input/stress	Foot form	T3S
	Cycle 1	[<u>4</u> 3]	(4 3)	(4 3)
	Cycle 2	[(<u>4</u> 3) 3]	(4 3 3)	(4 2 3)

On cycle 1, the inner [4 3] is treated as a compound, which forms a left-headed foot. On cycle 2, the final syllable is not a syntactic nonhead and has no stress, so it can merge with the preceding foot and undergoes obligatory T3S.[5] Similarly, consider the compound in (21), from Dell's (21b), where the second syllable again must undergo T3S. The analysis is given in (22).

(21) 4 3 3 4 → 4 2 3 4
[[[zao tong] chang] wai]
make pail factory outside
'outside the pail-making factory'

(22)	[[[4 3] 3] 4]	Input/stress	Foot form	T3S
	Cycle 1	[<u>4</u> 3]	(4 3)	(4 3)
	Cycle 2	[(<u>4</u> 3) 3]	(4 3 3)	(4 2 3)
	Cycle 3	[(<u>4</u> 2 3) 4]	(4 2 3 4)	(4 2 3 4)

Again, on cycle 2 and cycle 3, the final syllable has no phrasal stress, so it can merge with the preceding foot.[6]

As Dell points out, if T3S is optional between two feet, and if (19) is analyzed as two feet (4 3)(3 Ø), where Ø is an empty beat (zero syllable), as suggested in Duanmu

[5] Once again, if T3S is obligatory for both '3(3…' and '…3)3', there is no need to assume that the final syllable on cycle 2 in (20) must join in the foot

[6] Duanmu (2000) suggests that a foot cannot cross a clause boundary. The suggestion is meant to explain the rarity of certain VN compounds where the N is the semantic subject of V. For example, English has *tow-truck* but no *move-truck* (a truck to move things). If the present analysis is correct, the lack of VN compounds must be due to morphological reasons (compounds are not always productive), instead of phonological reasons.

(2000: 185), the results would be incorrect. I agree with Dell and believe that the above analysis is better. However, the empty beat is needed in some cases, to be discussed next.

2.5. The empty beat (zero syllable) and T3S

Consider the structure in (23), similar to Dell's (23), where the second syllable must undergo T3S.

(23) x x
(4 3) (3 Ø) → (4 2)(3 Ø)
[gou-mai jiu]
buy wine
'buy wine'

In the analysis of Duanmu (2000) the compound verb forms a foot. The object has phrasal stress and forms another foot. Since the object is in final position, it can form a binary foot with an empty beat Ø (also called a zero syllable or a rest). Dell raises two questions for the analysis. First, if there are two feet in (23), T3S should be optional, yet it is obligatory here. Second, the use of the empty beat seems to be rather unconstrained. With regard to the first question, let us compare (23) with (24), an example already used in (8) above.

(24) (3 3) (3 1) → (2 3)(3 1)
[xiang [mai [hao shu]]]
want buy good book
'(I) want to buy good books'

In (24) the medial 3-3 need not undergo T3S, which shows that T3S is optional between two feet (although some speakers may prefer to apply T3S here anyway), yet the 3-3 in (23) must undergo T3S. In Chen's analysis (23) forms one foot and T3S is expected to be apply. In Duanmu's (2000) analysis the difference is unexplained.

I suggest that the difference lies in two kinds of feet: one made of two syllables (σσ) and one made of a syllable and an empty beat (σØ). T3S is optional across the former but obligatory across the latter. Although it might seem simpler not to assume (σØ) or the empty beat at all, there are reasons to recognize (σØ). First, the stress pattern in (23) is SWS, about which most linguists agree, including Hoa and Chen; if so, there should be two feet. Second, the effect of the empty beat—a pause or a lengthening of the preceding syllable—is also quite obvious. Naturally, many linguists have proposed the empty beat before, such as Burling (1966), Liberman (1975), Giegerich (1985), and Hayes (1995). A difference between two kinds of feet has also been proposed before by Burzio (1994) for English (strong vs. weak feet). Moreover, in Chinese (σσ) can satisfy the minimal word requirement (for a noun to be spoken alone, for example), but (σØ) usually cannot.

The empty beat usually occurs at major syntactic boundaries, but it can also occur elsewhere. For example, consider the English verse lines in (25).

(25) Ding Ø dong Ø bell Ø
Kitty's in the well Ø

Burling (1966) argues that, since the second line has two more syllables, it would be hard to see how the two lines could be parallel (each forming three syllabic trochees), unless one understands the role of empty beats, as shown. Phonetically, the two lines are read with similar durations, whereby the first two syllables of the first line are either long or followed by a pause, and so are the final syllables of both lines.

Next consider Dell's criticism that the use of the empty beat adds too much power to a theory. The concern is valid if the empty beat has no phonetic correlates. However, if the empty beat is a phonetic fact, it should be recognized. A theory that accounts for such phonetic effects is better than one that does not.

2.6. T3S and neutralization

Dell (2004, section 3.5) argues that, because T3S changes T3 to T2, the result is neutralizing. In addition, because of 'the cross-linguistic generalization that unstressed positions are more susceptible than stressed ones to neutralization processes', it is better to assume that the initial syllable of a foot (which undergoes T3S) is weak and the final syllable (which does not undergo T3S) is strong.

There are several problems with Dell's argument. First, as I will discuss in section 3.4, the stress locations proposed by Duanmu (2000) largely agree with the judgment of native speakers, and even right-headed analyses assume that many feet are in fact left-headed. Thus, no one assumes that all feet are right-headed. For example, all analyses (such as Hoa 1983, Chen 2000, and Duanmu 2000) consider the stress pattern of (26) to be SWS, where the first syllable is strong, yet it must undergo T3S.

(26) 3 3 1 → 2 3 1
[[mai hao] shu]
buy well book
'have bought books.'

Thus, there is no evidence that T3S applies to an unstressed or less-stressed syllable only. Second, T2 is a full syllable, which contrasts with T1, T4, T3, and weak syllables. So when T3 changes to T2, it remains a full syllable, not a weak syllable. In this regard, T3S differs from typical neutralization processes, where all contrasts in a given paradigm are lost, and the result is often none of the originally contrastive forms. For example, the flapping rule in American English neutralizes /t/ and /d/ and the result is [ɾ]. Similarly, when stressed vowels neutralize in American English, the result is [ə], which does not occur in a stressed syllable (I assume that the vowel in words like *cup* is [ʌ], not [ə]; see Hammond 1999). Thus, to equate T3S with neutralization is to overlook a number of important differences between them.[7] Third, if T3S applies to an unstressed syllable (or a less-stressed syllable), as Dell suggests, it should be suspended when the syllable gets extra stress, but this is not the case. Consider the example in (27), which has no contrastive stress, and (28), where words in uppercase have contrastive stress.

[7] Since T3 is a low tone, a more likely characterization of T3S is that it is a dissimilation between two low tones.

(27) (3 3) (3 1) → (2 3)(3 1)
ni mai hao shu
you buy good book
'You buy good books.'

(28) (3 3) (3 1) → (2 3)(3 1)
NI mai hao shu (TA bu mai)
you buy good book (he not buy)
'YOU buy good books (HE does not).'

Whether or not *ni* has contrastive stress, it must undergo T3S. This is unexpected for Dell, but expected in Duanmu's analysis: the foot is trochaic anyway, and adding stress to the initial syllable does not change the foot. Similarly, consider (29), where contrastive stress changes foot boundaries.

(29) 3 (3 3 1) → 3 (2 3 1)
ni MAI hao shu (bu JIE hao shu)
you buy good book (not borrow good book)
'You BUY good books (not BORROW good books).'

The first clause in (29) has the same syntax as (27), but they have different foot structures. As Chen (2000) observes, the contrastive stress on *mai* triggers a new foot boundary. If the foot is right-headed, as Dell suggests, there is no reason for *mai* to start a new foot in (29), because it has stress anyway. In contrast, if the foot is left-headed, the extra stress on *mai* will start a new foot. We see, too, that *mai* must undergo T3S, even though it has extra stress.

In summary, while T3S changes T3 to T2, it differs from typical neutralization cases triggered by stress reduction. The right-headed analysis offers no better solution.

2.7. T2S (Tone 2 Sandhi) and neutralization

Besides T3S, SC also has a rule, shown in (30), by which T2 (LH) changes to T1 (H) when it occurs after T1 (H) or T2 (LH) and before another full syllable (shown as T). Let us call it T2S.

(30) T2S: 2 → 1 / {1, 2}__T
Or: H-LH-T → H-H-T
LH-LH-T → LH-H-T

T2S seems to be a tonal simplification because it simplifies a sequence of H-LH to H-H. Duanmu (2000: 139) observes that the syllable that undergoes T2S usually has no phrasal or compound stress. If so, it is natural for it to undergo tonal simplification in the given environment. However, Duanmu (2000: 223) cautions that if T2S is the result of stress reduction, it should apply to T3 or T4 as well, which it does not. So whether or not T2S is triggered by stress reduction is not completely obvious.

T2S is originally discussed in Chao (1968), who gives eleven examples, shown in (31), where syllables that receive phrasal stress in Duanmu's analysis are underlined.

(Notations: MM is a disyllabic modifier, M a monosyllabic modifier, NN a disyllabic noun, N a monosyllabic noun, Aux an auxiliary verb, Adv an adverb, V a verb, and Neg a negation).

(31)

Structure	# of cases	Example
[MM N]	6	xi-yang sheng 'western ginseng'
[M NN]	2	san nian-ji 'third grade'
[N [Aux V]]	1	shei neng fei 'Who can fly?'
[[Adv Neg] V]	1	hai mei wan 'still not finished'
[[Adv N] N]	1	hao ji zhong 'quite several kinds'

In none of the cases does the second syllable have phrasal stress. The analysis of Hoa (1983) is similar: all the forms have the stress pattern SWS, where the second syllable has no stress. Of relevance is the fact that when the second syllable has contrastive stress, T2S will not apply. An example is given in (32), based on the third case in (31).

(32) 2 2 1 → *2 1 1
shei NENG fei (bu-shi shei XIANG fei)
who can fly (not who want fly)
'Who CAN fly (not who WANT to fly)'

In (32), the second syllable has contrastive stress and cannot undergo T2S. This supports the idea that T2S applies to syllables without phrasal stress.

In Chao's examples there is no [V OO], where OO is a disyllabic object. In Duanmu's analysis the absence of [V OO] is not an accident, because in [V OO] main stress is on the second syllable and T2S should not apply. However, Dell (2004) suggests that T2S can apply to [V OO] and offers the example in (33).

(33) 1 2 4 → 1 1 4
chi yang-rou
eat sheep meat
'eat mutton'

Dell argues that since T2S applies to unstressed syllables, *yang* cannot have main stress in (33), and Duanmu's stress rule is incorrect. Now Dell seems to assume Hoa's analysis that in a trisyllabic expression the second syllable is always unstressed. If so, the expressions in (34) and (35) should have no tonal difference, yet they clearly do.

(34) 1 3 3 → 1 2 3 → 1 1 3
[[he hao] jiu]
drink finish wine
'have drunk wine'

(35) 1 3 3 → 1 2 3 → ??1 1 3
[he [hao jiu]]
drink good wine
'drink good wine'

At normal speed, the surface pattern of (34) is 1-1-3 (where both T3S and T2S apply), but that in (35) is 1-2-3 (where only T3S applies). This is the case in general, namely, it is more difficult to apply T2S in [V OO]. In fact, Dell is careful to say that T2S applies to (33) and (35) only 'in fast speech'. In Duanmu's analysis, this is expected: the second syllable in (34) has no phrasal stress, so it can undergo T2S, but that in (35) has phrasal stress, so it cannot undergo T2S easily. In fast speech, stress reduction may occur, and the object may perhaps lose stress. In contrast, if the second syllable never gets phrasal stress, the difference between (34) and (35) remains a mystery.

2.8. Evidence from other dialects

Duanmu (2000) argues that the stress analysis he proposes for SC works the same way in Shanghai and some other Wu dialects, which provides additional support for the analysis. Dell (2004, section 6) argues that evidence from other dialects is irrelevant, because each dialect can in principle have different stress rules. Dell also notes that Duanmu (1995) proposed that SC and Xiamen have different stress rules.

If dialects can in principle have different stress rules, then stress patterns in other dialects are indeed irrelevant. But there is also another possibility, namely, all languages have the same phrasal stress rule. This is the position adopted in Duanmu (1999), where the analysis of Xiamen by Duanmu (1995) was rejected. Duanmu (2000) also believes that there is a universal phrasal stress rule. I will return to this issue in section 3.

2.9. Classic verse

In a brief note, Duanmu (2000: 142) suggests that Chinese verse patterns support his metrical analysis. Dell (2004, section 7) argues that the cited examples were from classic verse and so they are irrelevant, because modern Chinese may have different stress rules. I will offer additional evidence from modern Chinese verse in section 3 and argue that verse patterns are relevant.

2.10.Summary

I have shown that, with minor modifications or reinterpretations of Duanmu (2000), all of Dell's criticisms can be accounted for, and an analysis based on left-headed feet remains the simplest theory of stress in SC.

3. FURTHER ISSUES

I this section I discuss four further issues that provide additional arguments for Duanmu (2000): a general theory of phrasal stress, the analysis of grammatical words, evidence for left-headed feet in Chinese verse, and phonetic judgment on stress.

3.1. A general theory of phrasal stress

Duanmu (2000) proposes that in compounds and phrases stress is assigned to the

syntactic nonhead. The rule is called Nonhead Stress. In this section I explore a more fundamental principle that underlies Nonhead Stress.

To begin, consider contrastive stress. I take it to be uncontroversial that all languages use contrastive stress. The reason for contrastive stress, it seems, is that words under contrast carry more information of interest, and the more information a word carries the more stress it receives. Let us state the hypothesis in (36).

(36) The Information-Stress Principle:
A syntactic constituent that carries more information than its neighbor(s) should be stressed.

I will argue that a range of stress phenomena can be explained by the Information-Stress Principle. First, consider Nonhead Stress. In standard X-bar syntax, the head is an element at the word or affix level, and a nonhead is an element at the phrase level. Since there are more possible phrases than possible words or affixes, the occurrence of a nonhead (phrase) is less predictable than the occurrence of a head (word or affix). According to Information Theory (Shannon and Weaver 1949), the more predictable an expression is, the less information it carries. It follows that a syntactic nonhead carries more information than its syntactic head, and by the Information-Stress Principle, the syntactic nonhead should be stressed.

When a word carries focus or emphasis, it can override Nonhead Stress. This is because the information on the focused word now exceeds that on other words. As a result, phrasal stress can be flexible, because the information load of each word is only partly dependent on syntax and the speaker can give extra information to any word.

An interesting mirror-image of emphasis is pronouns, which usually do not carry stress, even if they are in nonhead positions (such as the subject or the object position). This phenomenon also follows from the Information-Stress Principle: pronouns are used when their referents are contextually obvious or have just been mentioned, and so they do not carry new information.

As a final example, consider the difference between function words and content words. The former are often unstressed, whereas the latter are usually stressed. In the present analysis, there are two reasons. First, function words are closed-class words (small in number) and so high in probability of occurrence. By Information Theory they are low in information content, and by the Information-Stress Principle they do not carry stress. In contrast, content words are open-class words (large in number) and so low in probability of occurrence. By Information Theory they are high in information content, and by the Information-Stress Principle they should generally carry stress. Second, function words mostly occur in syntactic head positions, which do not have stress. In contrast, content words often occur in non-head positions, which have stress.

The idea that there might be a universal rule for compound and phrasal stress has been proposed, in a different form, by Cinque (1993). According to Cinque, the degree of stress is related to the depth of a syntactic tree: the deeper a branch, the more stress it has. Since a syntactic head is usually a word (or an affix), which generally does not branch, and the syntactic nonhead is a phrase, which always branches, the syntactic nonhead is generally deeper and has more stress than the syntactic head. Thus, Cinque's theory predicts similar stress patterns as Nonhead Stress.

3.2. Grammatical words

Shih (1986) and Chen (2000) observe that grammatical words, such as classifiers and prepositions, pose a problem for the foot formation process. Consider the example in (37), where both of the first two syllables must undergo T3S.

(37) 3 3 3 → 2 2 3 (Not possible: *3 2 3)
[mai [wan jiu]]
buy bowl wine
'buy a bowl of wine'

According to the foot formation rules of Shih (1986) and Chen (2000), a foot is first built for a disyllabic syntactic unit before a super-foot is built. If so, (37) is analyzed in (38)

(38)	[3 [3 3]]	Input	Foot form	T3S
	σσ-foot	[3 [3 3]]	[3 (3 3)]	[3 (2 3)]
	Super-foot	[3 (2 3)]	(3 2 3)	*(3 2 3)

The analysis predicts that the first syllable need not undergo T3S, which is incorrect. To solve the problem, Shih (1986) and Chen (2000) propose that certain grammatical words, such as classifiers and prepositions, cliticize to the word on their left. In (37), the classifier *wan* 'bowl' will cliticize to *mai* 'buy' and so the structure changes from [3 [3 3]] to [[3 3] 3]. The analysis after cliticization is in (39), which gives the correct result.

(39) Analysis after cliticization ([3 [3 3]] → [[3 3] 3])

[[3 3] 3]	Input	Foot form	T3S
σσ-foot	[[3 3] 3]	[(3 3) 3]	[(2 3) 3]
Super-foot	[(2 3) 3]	(2 3 3)	(2 2 3)

In Duanmu (2000) there is no need to assume cliticization. The analysis is shown in (40).

(40)	[3 [3 <u>3</u>]]	Input	Foot form	T3S
	Compound	[3 [3 <u>3</u>]]	[3 [3 (3 Ø)]	[3 [3 (3 Ø)]
	Phrase (L→R)	[3 [3 (3 Ø)]	(3 3)(3 Ø)	(2 3)(3 Ø)
	T3S			(2 2)(3 Ø)

In the object, the classifier *wan* 'bowl' is the syntactic head and the noun *jiu* 'wine' is the nonhead, following Abney (1987) and Pollock (1989), according to which grammatical or functional elements are syntactic heads. At the word/compound level, *jiu* 'wine' has stress and can form a foot with an empty beat. At the phrase level, the two free syllables form another foot, in which T3S applies. Finally, because the second foot is a weak foot, T3S applies again between the feet, giving the expected 2-2-3. As another example, consider (41), where the neutral pattern is 2-3-2-3.

(41) 3 3 3 3 → 2 3 2 3
[gou [[bi ma] xiao]'
dog than horse small
'Dogs are smaller than horses.'

If a foot is first built for the disyllabic unit [*bi ma*] 'than horse', then *bi* must undergo T3S, which is not the case. Thus, Chen (2000) must assume cliticization for *bi*, which attaches left to *gou* 'dog', so that the structure is changed to [[3 3][3 3]], which then forms two feet (3 3)(3 3), giving (2 3)(2 3) after T3S. In Duanmu (2000) there is again no need to assume cliticization. The analysis is shown in (42).

(42)	Input	Foot form	T3S
	[3 [[3 3] 3]	(3 3)(3 3)	(2 3)(2 3)

There are two syntactic nonheads—the subject and the object of the preposition. Thus, the sentence forms two feet,[8] and after T3S we get the expected 2-3-2-3.

3.3. Feet in Chinese verse

There is a common consensus that classic Chinese verse lines form disyllabic feet from left to right, although there is some disagreement on the final three syllables that need not concern us (see Chen 1979, Duanmu 2004). Chen offers two arguments that the feet are iambic. First, in recitation even-numbered syllables are longer. Second, even-numbered syllables have fewer choices for tone. Duanmu (2004) argues that recitation is variable and should not be used as crucial evidence, a view commonly shared in generative metrics. In addition, there is no explanation why stressed syllables should have fewer choices for tone, instead of having more choices. Moreover, Duanmu offers two arguments that the Chinese verse feet are trochaic. First, stress maxima must occur in odd-numbered positions, as they do in English (Halle and Keyser 1971, Fabb 2002). Second, weak words, such as prepositions, conjunctions, and verbs, generally occur in even-numbered positions.

Dell argues that evidence from classic Chinese has no relevance for modern Chinese. However, without counter evidence, it is the null hypothesis that classic Chinese and modern Chinese have the same stress pattern. In addition, if phrasal stress is based on a universal principle, as I proposed in section 3.1, it is unlikely to change over time. Indeed, I will show that modern folk verse works the same way as classic verse.

There is a large body of modern folk verse that circulates orally among the populace in China. Many of the poems are anonymous social satires As with nursery rhymes, native speakers usually have a good judgment on whether a verse line is rhythmic or not, and most of the ones in circulation are.

As in classic verse, a weak monosyllabic word in modern folk verse generally cannot occur in odd-numbered positions (positions 1, 3, and 5), unless it is followed by

[8] The example in (41) and (42) is discussed in Duanmu (2000: 251). The foot formation requires a stressed monosyllable to form a foot with a following unstressed syllable. In a derivational analysis (not fully spelled out in Duanmu 2000), this rule can be ordered after cyclic foot formation in compounds and before left to right foot formation.

another weak monosyllabic word. Weak monosyllabic words include tense/aspect markers, prepositions, and verbs (see Ladd 1980: 84-90 for English), whereas strong monosyllabic words are nouns, adjectives, and adverbs. Consider the examples in (43)-(48). The good examples are taken from http://www.haha365.com/default.asp?classid=2; each line is followed by a category and serial number of the poem it occurs in. The marginal examples (indicated by '??') are constructed lines. The judgment is based on consultation with several native speakers.

(43) bang ge dakuan ba fu xiang (Shehui 'Society': 44)
lean-on a rich-man with pleasure enjoy
'Lean on a rich man and enjoy pleasure.'

(44) ?? bang xin dakuan ba fu xiang
lean-on new rich-man with pleasure enjoy
'Lean on new rich men and enjoy pleasure.'

(45) zheng de piaozi shu bu qing (Wangmin 'Web': 77)
make DE notes count not clear
'The money made cannot be counted'

(46) ??ni-men de qian shu bu qing
you DE money count not clear
'Your money cannot be counted'

(47) kao-chang li you ti-shen zai (Xiaoyuan 'Campus': 69)
exam-room inside have substitute-body there
'The exam room has proxies there.'

(48) ?? kao-chang li gang you ti-shen
exam-room inside just have substitute-body
'The exam room has just had proxies.'

In (43) the weak word *bang* is in position 1 but followed by a weak word *ge*, so the line is fine. In (44) the weak word *bang* is in position 1 and followed by a strong word *xin*, so the line is marginal. In (45) the weak word *de* is in position 2, so the line is fine. In (46) the weak word *de* is in position 3, so the line is rhythmically marginal. In (47) the weak word *li* is in position 3 and followed by a weak word *you*, so the line is fine. In (48) the weak word *li* is in position 3 and followed by a strong word *gang*, so the line is marginal. The distribution of weak words suggests that the odd-numbered positions are strong, and the template for Chinese verse is SWSW…. Now since disyllabic words predominantly fill either positions 1-2 or positions 3-4, but not positions 2-3 (the last three syllables of a line involve additional complications and are not discussed here), their rhythmic pattern is SW, which is trochaic.

3.4. Phonetic judgment for stress in SC: Hoa (1983)

The stress analysis of Duanmu (2000) mainly relies on phonological arguments.

Apart from the difference between full and weak syllables, there is little reference to evidence from native judgment. It remains to be seen whether the stress positions predicted by Duanmu agree with native judgment.

Most phonetic studies of stress in SC are based on words or short phrases. An exception is Hoa (1983), which looks at native judgment on a wide range of structures, including whole sentences. Hoa offers a number of insights, which Duanmu (2000) fails to mention, unfortunately. In this section I compare Hoa (1983) and Duanmu (2000) and show that they predict similar results. Since Hoa uses the tree notation of Liberman and Prince (1977), instead of bracketed feet, the comparison will focus on the locations of stress.

At first sight Hoa's theory seems to be quite different, because stress is cyclically assigned to the right, whereas in Duanmu's analysis stress is assigned to the left in compounds and to the right in phrases. However, if we factor out pre-pause lengthening, the two analyses make very similar predictions.

Hoa discusses stress in three parts, polysyllabic names, lexical stress in some disyllabic compounds, and a general stress rule for other compounds and phrases.[9] First consider polysyllabic names. A comparison between Duanmu (2000) and Hoa (1983: 181) is shown in (49), where 1 is stronger than 2 and 2 is stronger than 3; x is weaker than 2 for Duanmu and weaker than 3 for Hoa. When Hoa gives alternative stress patterns for a given word length, only one of these is shown.

(49)

Length	Duanmu	Hoa
σσ	1-x	2-1
σσσ	1-x-2	2-x-1
σσσσ	1-x-2-x	2-x-x-1
σσσσσ	1-x-2-x-2	2-x-3-x-1
σσσσσσ	1-x-2-x-2-x	2-x-3-x-x-1
σσσσσσσ	1-x-2-x-2-x-2	2-x-3-x-3-x-1

For Duanmu left-headed binary feet are built from left to right, where1 and 2 are the head of a foot and x is not (Duanmu also assumes that main stress is on the initial syllable). For Hoa the same seems to be true, except for the final syllable, which is always thought to be the strongest. Hoa's judgment of the final syllable is probably influenced by final lengthening (Klatt 1976). Phonetic studies show that when a SC word or compound is spoken in isolation its final syllable is often longer (Yan and Lin 1988), but when a word or compound is spoken in a carrier sentence its final syllable is not longer any more (Wang and Wang 1993). If Hoa's judgment is influenced by final lengthening, then the two analyses are nearly identical.

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[9] Hoa (1983) seems to treat some disyllabic compounds, such as *bei guan* 'sad view (pessimistic)' and *wai guo* 'foreign country', as lexical words (see her Appendix III) and other disyllabic compounds, such as *da jiang* 'big river' and *hei yun* 'black cloud', as phrases. In addition, Hoa seems to treat all trisyllabic or longer compounds as phrases. I follow Dai (1992) and Duanmu (2000) and assume that all [N N] and [M N] nominals, where M is a modifier of N, are compounds.

Next consider lexical stress in disyllabic compounds, where Hoa distinguishes three patterns, 1-0, 2-1, and 1-2, where 0 means no stress. 1-0 is easy to distinguish, because 0 is a weak syllable that is short, with no lexical tone, and with a reduced rime. 2-1 is the regular case for Hoa, because she consistently assigns right-headed stress for disyllabic names, regular compounds, and phrases. 1-2 seems to be a problem for Hoa, because it differs from the basic pattern of final stress and is not reported in Chao (1968), who also assumes final stress. One explanation, offered by Meredith (1990) and referred to in Duanmu (2000), is that Hoa's judgment is influenced by tone: there seems to be a preference for T4 and T1 to be judged as stronger than T2 and T3, although some exceptions exist.

In the left-headed analysis of Duanmu, disyllabic words should either be 1-0 or 1-2, and the pattern 2-1 is probably due to final lengthening. Interestingly, Hoa (1983: 196) observes that frequent words tend to be 1-2 and infrequent words tend to be 2-1. If we assume that frequent words better represent the default stress pattern, then Hoa's observation favors left-headed feet. Frequency studies show that infrequent words are read more carefully (Hooper 1976, Bybee 2001 and references therein), and it is natural for final lengthening to apply more easily to them. The left-headed analysis also explains why there is no 0-1, for which Hoa needs a separate assumption.

Next consider stress in phrases. According to Hoa, phrasal stress is always assigned to the right. According to Duanmu, stress is assigned to the syntactic nonhead, which in phrases are mostly on the right, as in [V O] and [P N]. Thus, the two analyses are similar.

Finally, consider stress in regular compounds. According to Hoa, compound stress is assigned to the right, but according to Duanmu it is assigned to the left, because the syntactic nonhead is on the left. The two analyses seem to be contradictory, but the difference turns out to be quite small. Consider the examples in (50), where S is a syllable that is assigned stress and W is one that is not.

(50)	Structure	Duanmu	Hoa
	[N N]	SW	WS
	[N [N N]]	[S [SW]] → SWW	[W [WS]] → SWS
	[[N N] N]	[[SW] W] → SWW	[[WS] S] → SWS

The difference in [N N] is similar to that in disyllabic words. For [N [N N]], Duanmu assumes stress clash avoidance, which removes stress from the second S. Although Hoa assigns WWS to [N [N N]], she interprets it as SWS, assuming something equivalent to the Stress Equalization Convention of Halle and Vergnaud (1987). For [N [N N]], Duanmu makes no new assumption; Hoa assumes stress clash avoidance and stress inversion, which reverses the inner WS to SW. The final results are quite similar, except that for Hoa the final syllable is strong, again probably because of the final lengthening effect. Next consider [[N N][N N]], shown in (51).

(51)	Structure	Duanmu	Hoa
	[[N N][N N]]	SWSW	WSWS→SWWS

For Duanmu the structure has two disyllabic compounds and there is no additional assumption. For Hoa the output should be WSWS, which does not incur stress clash. However, Hoa assumes another rule, which reverses the first WS anyway. Thus, the results are again similar, except for the final syllable.

While the analyses of Duanmu and Hoa are similar so far, an interesting observation by Hoa points to a crucial difference: in [M N] compounds (where M is a modifier of N), main stress is on M, but in [V O] phrases main stress is on O. Consider the examples in (52) and (53), from Hoa (1983: 102).

(52)

1 x 2 x	2 x 1 x
chuang-zao tian-cai	chuang-zao tian-cai
create genius	create genius
'creative genius'	'to create genius'

(53)

1 2	2 1
guai ren	guai ren
weird person	blame person
'a weird person'	'to blame someone'

The examples in each pair are phonologically identical except in main stress. In Hoa's analysis, the difference between [M N] and [V O] remains a puzzle. In Duanmu's analysis the difference is expected: in [M N], M is the syntactic nonhead and gets main stress, and in [V O], O is the syntactic nonhead and gets main stress.

In summary, when the effect of final lengthening is factored out, the analyses of Duanmu and Hoa offer very similar predictions. This means that the analysis of Duanmu (2000) is supported by the phonetic judgment of native speakers. It also shows that right-headed stress needs to make additional assumptions in order to account for such effects as the lack of 0-1 words, stress inversion in expressions that do not have stress clash, and the difference between [V O] phrases and [M N] compounds.

4. CONCLUSIONS

I have argued that the simplest analysis of feet in Chinese is that they are left-headed (Duanmu 2000). Right-headed analyses, such as Hoa (1983) and Chen (2000), predict similar stress locations (if we factor out pre-pause lengthening), yet they must assume both left-headed feet and right-headed feet. In addition, to account for tone sandhi in Standard Chinese, Chen must assume an unusual phonological entity (the Minimal Rhythmic Unit) in which stress can occur anywhere and more than once, such as (SW), (WS), (SWS), (WSW), and so on.

Interestingly, while Dell (2004) makes a number of criticisms of Duanmu (2000) in favor of Hoa (1983) and Chen (2000), he does not adopt the analysis of Hoa or Chen. Instead, Dell states that 'I do not have an alternative account of stress and tone sandhi in (Standard Chinese)' and that his criticisms are meant to 'be of help in devising an alternative'. In my view Dell's criticisms are acute and mostly correct, but his rejection of left-headed feet is premature, because he does not give adequate consideration to whether the problems he raises are solvable. I have shown that, with some modifications of

Duanmu (2000), all of Dell's concerns can be resolved, and the analysis with left-headed feet remains the simplest theory of stress in Chinese.

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